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**Ada COMPILER  
VALIDATION SUMMARY REPORT:  
Certificate Number: #890720N1.10124  
Alsys Limited  
AlsysCOMP\_023 Version 4.2  
IBM 370 3084Q**

**Completion of On-Site Testing:  
20 July 1989**

**Prepared By:  
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United States Department of Defense  
Washington DC 20301-3081**

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# Ada Compiler Validation Summary Report:

Compiler Name: AlsysCOMP\_023 Version 4.2

Certificate Number: #890720N1.10124

Host: IBM 370 3084Q under MVS 3.2

Target: IBM 370 3084Q under MVS 3.2

Testing Completed 20 July 1989 Using ACVC 1.10

This report has been reviewed and is approved.

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## CHAPTER 1

## INTRODUCTION

This Validation Summary Report (VSR) describes the extent to which a specific Ada compiler conforms to the Ada Standard, ANSI/MIL-STD-1815A. This report explains all technical terms used within it and thoroughly reports the results of testing this compiler using the Ada Compiler Validation Capability (ACVC). An Ada compiler must be implemented according to the Ada Standard, and any implementation-dependent features must conform to the requirements of the Ada Standard. The Ada Standard must be implemented in its entirety, and nothing can be implemented that is not in the Standard.

Even though all validated Ada compilers conform to the Ada Standard, it must be understood that some differences do exist between implementations. The Ada Standard permits some implementation dependencies -- for example, the maximum length of identifiers or the maximum values of integer types. Other differences between compilers result from the characteristics of particular operating systems, hardware, or implementation strategies. All the dependencies observed during the process of testing this compiler are given in this report.

The information in this report is derived from the test results produced during validation testing. The validation process includes submitting a suite of standardized tests, the ACVC, as inputs to an Ada compiler and evaluating the results. The purpose of validating is to ensure conformity of the compiler to the Ada Standard by testing that the compiler properly implements legal language constructs and that it identifies and rejects illegal language constructs. The testing also identifies behavior that is implementation dependent, but is permitted by the Ada Standard. Six classes of tests are used. These tests are designed to perform checks at compile time, at link time, and during execution.

### 1.1 PURPOSE OF THIS VALIDATION SUMMARY REPORT

This VSR documents the results of the validation testing performed on an Ada compiler. Testing was carried out for the following purposes:

- To attempt to identify any language constructs supported by the compiler that do not conform to the Ada Standard
- To attempt to identify any language constructs not supported by the compiler but required by the Ada Standard
- To determine that the implementation-dependent behavior is allowed by the Ada Standard

Testing of this compiler was conducted by The National Computer Centre Limited according to procedures established by the Ada Joint Program Office and administered by the Ada Validation

Organization (AVO). On-site testing was completed 20 July 1989 at Alsys Limited, Partridge House, Newtown Road, Henley-on-Thames, Oxfordshire, RG9 1EN, United Kingdom

### 1.2 USE OF THIS VALIDATION SUMMARY REPORT

Consistent with the national laws of the originating country, the AVO may make full and free public disclosure of this report. In the United States, this is provided in accordance with the "Freedom of Information Act" (5 U.S.C. #552). The results of this validation apply only to the computers, operating systems, and compiler versions identified in this report.

The organizations represented on the signature page of this report do not represent or warrant that all statements set forth in this report are accurate and complete, or that the subject compiler has no nonconformities to the Ada Standard other than those presented. Copies of this report are available to the public from:

Ada Information Clearinghouse  
Ada Joint Program Office  
OUSDRE  
The Pentagon, Rm 3D-139 (Fern Street)  
Washington DC 20301-3081

or from:

Testing Services  
The National Computing Centre Limited  
Oxford Road  
Manchester M1 7ED  
England

Questions regarding this report or the validation test results should be directed to the AVF listed above or to:

Ada Validation Organization  
Institute for Defense Analyses  
1801 North Beauregard Street  
Alexandria VA 22311

### 1.3 REFERENCES

1. Reference Manual for the Ada Programming Language, ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987.
2. Ada Compiler Validation Procedures and Guidelines, Ada Joint Program Office, 1 January 1987.

3. Ada Compiler Validation Capability Implementers' Guide, SofTech, Inc., December 1986.
4. Ada Compiler Validation Capability User's Guide, December 1986.

## 1.4 DEFINITION OF TERMS

ACVC	The Ada Compiler Validation Capability. The set of Ada programs that tests the conformity of an Ada compiler to the Ada programming language.
Ada Commentary	An Ada Commentary contains all information relevant to the point addressed by a comment on the Ada Standard. These comments are given a unique identification number having the form AI-ddddd.
Ada Standard	ANSI/MIL-STD-1815A, February 1983 and ISO 8652-1987.
Applicant	The agency requesting validation.
AVF	The Ada Validation Facility. The AVF is responsible for conducting compiler validations according to procedures contained in the <u>Ada Compiler Validation Procedures and Guidelines</u> .
AVO	The Ada Validation Organization. The AVO has oversight authority over all AVF practices for the purpose of maintaining a uniform process for validation of Ada compilers. The AVO provides administrative and technical support for Ada validations to ensure consistent practices.
Compiler	A processor for the Ada language. In the context of this report, a compiler is any language processor, including cross-compilers, translators, and interpreters.
Failed test	An ACVC test for which the compiler generates a result that demonstrates nonconformity to the Ada Standard.
Host	The computer on which the compiler resides.
Inapplicable test	An ACVC test that uses features of the language that a compiler is not required to support or may legitimately support in a way other than the one expected by the test.
Passed test	An ACVC test for which a compiler generates the expected result.

---

Target	The computer which executes the code generated by the compiler.
Test	A program that checks a compiler's conformity regarding a particular feature or a combination of features to the Ada Standard. In the context of this report, the term is used to designate a single test, which may comprise one or more files.
Withdrawn test	An ACVC test found to be incorrect and not used to check conformity to the Ada Standard. A test may be incorrect because it has an invalid test objective, fails to meet its test objective, or contains illegal or erroneous use of the language.

## 1.5 ACVC TEST CLASSES

Conformity to the Ada Standard is measured using the ACVC. The ACVC contains both legal and illegal Ada programs structured into six test classes: A, B, C, D, E, and L. The first letter of a test name identifies the class to which it belongs. Class A, C, D, and E tests are executable, and special program units are used to report their results during execution. Class B tests are expected to produce compilation errors. Class L tests are expected to produce errors because of the way in which a program library is used at link time.

Class A tests ensure the successful compilation and execution of legal Ada programs with certain language constructs which cannot be verified at run time. There are no explicit program components in a Class A test to check semantics. For example, a Class A test checks that reserved words of another language (other than those already reserved in the Ada language) are not treated as reserved words by an Ada compiler. A Class A test is passed if no errors are detected at compile time and the program executes to produce a PASSED message.

Class B tests check that a compiler detects illegal language usage. Class B tests are not executable. Each test in this class is compiled and the resulting compilation listing is examined to verify that every syntax or semantic error in the test is detected. A Class B test is passed if every illegal construct that it contains is detected by the compiler.

Class C tests check the run time system to ensure that legal Ada programs can be correctly compiled and executed. Each Class C test is self-checking and produces a PASSED, FAILED, or NOT APPLICABLE message indicating the result when it is executed.

Class D tests check the compilation and execution capacities of a compiler. Since there are no capacity requirements placed on a compiler by the Ada Standard for some parameters -- for example, the number of identifiers permitted in a compilation or the number of units in a library -- a compiler may refuse to compile a Class D test and still be a conforming compiler. Therefore, if a Class D test fails to compile because the capacity of the compiler is exceeded, the test is classified as inapplicable. If a Class D test compiles successfully, it is self-checking and produces a PASSED or FAILED message during execution.



Class E tests are expected to execute successfully and check implementation-dependent options and resolutions of ambiguities in the Ada Standard. Each Class E test is self-checking and produces a NOT APPLICABLE, PASSED, or FAILED message when it is compiled and executed. However, the Ada Standard permits an implementation to reject programs containing some features addressed by Class E tests during compilation. Therefore, a Class E test is passed by a compiler if it is compiled successfully and executes to produce a PASSED message, or if it is rejected by the compiler for an allowable reason.

Class L tests check that incomplete or illegal Ada programs involving multiple, separately compiled units are detected and not allowed to execute. Class L tests are compiled separately and execution is attempted. A Class L test passes if it is rejected at link time -- that is, an attempt to execute the main program must generate an error message before any declarations in the main program or any units referenced by the main program are elaborated. In some cases, an implementation may legitimately detect errors during compilation of the test.

Two library units, the package REPORT and the procedure CHECK\_FILE, support the self-checking features of the executable tests. The package REPORT provides the mechanism by which executable tests report PASSED, FAILED, or NOT APPLICABLE results. It also provides a set of identity functions used to defeat some compiler optimizations allowed by the Ada Standard that would circumvent a test objective. The procedure CHECK\_FILE is used to check the contents of text files written by some of the Class C tests for Chapter 14 of the Ada Standard. The operation of REPORT and CHECK\_FILE is checked by a set of executable tests. These tests produce messages that are examined to verify that the units are operating correctly. If these units are not operating correctly, then the validation is not attempted.

The text of each test in the ACVC follows conventions that are intended to ensure that the tests are reasonably portable without modification. For example, the tests make use of only the basic set of 55 characters, contain lines with a maximum length of 72 characters, use small numeric values, and place features that may not be supported by all implementations in separate tests. However, some tests contain values that require the test to be customized according to implementation-specific values -- for example, an illegal file name. A list of the values used for this validation is provided in Appendix C.

A compiler must correctly process each of the tests in the suite and demonstrate conformity to the Ada Standard by either meeting the pass criteria given for the test or by showing that the test is inapplicable to the implementation. The applicability of a test to an implementation is considered each time the implementation is validated. A test that is inapplicable for one validation is not necessarily inapplicable for a subsequent validation. Any test that was determined to contain an illegal language construct or an erroneous language construct is withdrawn from the ACVC and, therefore, is not used in testing a compiler. The tests withdrawn at the time of this validation are given in Appendix D.

## CHAPTER 2

### CONFIGURATION INFORMATION

#### 2.1 CONFIGURATION TESTED

The candidate compilation system for this validation was tested under the following configuration:

Compiler: AlsysCOMP\_023 Version 4.2

ACVC Version: 1.10

Certificate Number: #890720N1.10124

#### Host Computer:

Machine: IBM 370 3084Q

Operating System: MVS 3.2

Memory Size: 7 Mbytes

#### Target Computer:

Machine: IBM 370 3084Q

Operating System: MVS 3.2

Memory Size: 2 Mbyte

Although the memory size is different between the Host computer and the Target computer, this validation was conducted on the same machine. On job submittal the user states the amount of memory required for processing the job.

#### 2.2 IMPLEMENTATION CHARACTERISTICS

One of the purposes of validating compilers is to determine the behavior of a compiler in those areas of the Ada Standard that permit implementations to differ. Class D and E tests specifically check for such implementation differences. However, tests in other classes also characterize an implementation. The tests demonstrate the following characteristics:

a. Capacities.

- (1) The compiler correctly processes a compilation containing 723 variables in the same declarative part. (See test D29002K.)
- (2) The compiler correctly processes tests containing loop statements nested to 65 levels. (See tests D55A03A..H (8 tests).)
- (3) The compiler correctly processes tests containing block statements nested to 65 levels. (See test D56001B.)
- (4) The compiler correctly processes tests containing recursive procedures separately compiled as subunits nested to 17 levels. (See tests D64005E..G (3 tests).)

b. Predefined types.

- (1) This implementation supports the additional predefined types `SHORT_INTEGER`, `SHORT_SHORT_INTEGER`, `SHORT_FLOAT`, `LONG_FLOAT`, in the package `STANDARD`. (See tests B86001T..Z (7 tests).)

c. Expression evaluation.

The order in which expressions are evaluated and the time at which constraints are checked are not defined by the language. While the ACVC tests do not specifically attempt to determine the order of evaluation of expressions, test results indicate the following:

- (1) No default initialization expressions for record components are evaluated before any value is checked for membership in a component's subtype. (See test C32117A.)
- (2) Assignments for subtypes are performed with the same precision as the base type. (See test C35712B.)
- (3) This implementation uses no extra bits for extra precision and uses all extra bits for extra range. (See test C35903A.)
- (4) `NUMERIC_ERROR` is raised when an integer literal operand in a comparison or membership test is outside the range of the base type. (See test C45232A.)
- (5) `NUMERIC_ERROR` is raised when a literal operand in a fixed-point comparison or membership test is outside the range of the base type. (See test C45252A.)
- (6) Underflow is not gradual. (See tests C45524A..Z (26 tests).)

d. Rounding.

The method by which values are rounded in type conversions is not defined by the language. While the ACVC tests do not specifically attempt to determine the method of rounding, the test results indicate the following:

- (1) The method used for rounding to integer is round away from zero. See tests C46012A..Z (26 tests.)
- (2) The method used for rounding to longest integer is round away from zero. (See tests C46012A..Z (26 tests).)
- (3) The method used for rounding to integer in static universal real expressions is round away from zero. (See test C4A014A.)

e. Array types.

An implementation is allowed to raise `NUMERIC_ERROR` or `CONSTRAINT_ERROR` for an array having a `'LENGTH` that exceeds `STANDARD.INTEGER'LAST` and/or `SYSTEM.MAX_INT`. For this implementation:

- (1) Declaration of an array type or subtype declaration with more than `SYSTEM.MAX_INT` components raises `NUMERIC_ERROR`. (See test C36003A.)
- (2) `NUMERIC_ERROR` is raised when `'LENGTH` is applied to an array type with `INTEGER'LAST + 2` components is declared. (See test C36202A.)
- (3) `NUMERIC_ERROR` is raised when an array type with `SYSTEM.MAX_INT + 2` components is declared. (See test C36202B.)
- (4) A packed `BOOLEAN` array having a `'LENGTH` exceeding `INTEGER'LAST` raises `NUMERIC_ERROR` when the array type is declared. (See test C52103X.)
- (5) A packed two-dimensional `BOOLEAN` array with more than `INTEGER'LAST` components raises `NUMERIC_ERROR` when subtypes are declared. (See test C52104Y.)
- (6) In assigning one-dimensional array types, the expression appears to be evaluated in its entirety before `CONSTRAINT_ERROR` is raised when checking whether the expression's subtype is compatible with the target's subtype. (See test C52013A.)
- (7) In assigning two-dimensional array types, the expression does not appear to be evaluated in its entirety before `CONSTRAINT_ERROR` is raised when checking whether the expression's subtype is compatible with the target's subtype. (See test C52013A.)

- f. (1) A null array with one dimension of length greater than INTEGER'LAST may raise `NUMERIC_ERROR` or `CONSTRAINT_ERROR` either when declared or assigned. Alternatively, an implementation may accept the declaration. However, lengths must match in array slice assignments. This implementation raises `NUMERIC_ERROR` when the array type is declared. (See test E52103Y.)
  
- g. Discriminated types.
  - (1) In assigning record types with discriminants, the expression appears to be evaluated in its entirety before `CONSTRAINT_ERROR` is raised when checking whether the expression's subtype is compatible with the target's subtype. (See test C52013A.)
  
- h. Aggregates.
  - (1) In the evaluation of a multi-dimensional aggregate, all choices appear to be evaluated before checking against the index type. (See tests C43207A and C43207B.)
  - (2) In the evaluation of an aggregate containing subaggregates, not all choices are evaluated before being checked for identical bounds. (See test E43212B.)
  - (3) `CONSTRAINT_ERROR` is raised after all choices are evaluated when a bound in a non-null range of a non-null aggregate does not belong to an index subtype. (See test E43211B.)
  
- i. Pragmas.
  - (1) The pragma `INLINE` is supported for functions or procedure calls within a body. The pragma `INLINE` for function calls within a declaration is not supported. (See tests LA3004A..B (2 tests), EA3004C..D (2 tests), and CA3004E..F (2 tests).)
  
- j. Generics.
  - (1) Generic specifications and bodies can be compiled in separate compilations. (See tests CA1012A, CA2009C, CA2009F, BC3204C, and BC3205D.)
  - (2) Generic subprogram declarations and bodies can be compiled in separate compilations. (See tests CA1012A and CA2009F.)

- (3) Generic library subprogram specifications and bodies can be compiled in separate compilations. (See test CA1012A.)
- (4) Generic non-library package bodies as subunits can be compiled in separate compilations. (See test CA2009C.)
- (5) Generic non-library subprogram bodies can be compiled in separate compilations from their stubs. (See test CA2009F.)
- (6) Generic unit bodies and their subunits can be compiled in separate compilations. (See test CA3011A.)
- (7) Generic package declarations and bodies can be compiled in separate compilations. (See tests CA2009C, BC3204C, and BC3205D.)
- (8) Generic library package specifications and bodies can be compiled in separate compilations. (See tests BC3204C and BC3205D.)

k. Input and output.

- (1) The package `SEQUENTIAL_IO` can be instantiated with unconstrained array types and record types with discriminants without defaults. (See tests AE2101C, EE2201D, and EE2201E.)
- (2) The package `DIRECT_IO` can be instantiated with unconstrained array types or record types with discriminants without defaults. (See tests AE2101H, EE2401D, and EE2401G.)
- (3) Modes `IN_FILE` and `OUT_FILE` are supported for `SEQUENTIAL_IO`. (See tests CE2102D..E (2 tests), CE2102N, and CE2102P.)
- (4) Modes `IN_FILE`, `OUT_FILE`, and `INOUT_FILE` are supported for `DIRECT_IO`. (See tests CE2102F, CE2102I..J (2 tests), CE2102R, CE2102T, and CE2102V.)
- (5) Modes `IN_FILE` and `OUT_FILE` are supported for text files. (See tests CE3102E and CE3102I..K (3 tests).)
- (6) `RESET` and `DELETE` operations are supported for `SEQUENTIAL_IO`. (See tests CE2102G and CE2102X.)
- (7) `RESET` and `DELETE` operations are supported for `DIRECT_IO`. (See tests CE2102K and CE2102Y.)
- (8) `RESET` and `DELETE` operations are supported for text files. (See tests CE3102F..G (2 tests), CE3104C, CE3110A, and CE3114A.)

## CONFIGURATION INFORMATION

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- (9) Overwriting to a sequential file truncates the file. (See test CE2208B.)
- (10) Temporary sequential files are given names and deleted when closed. (See test CE2108A.)
- (11) Temporary direct files are given names and deleted when closed. (See test CE2108C.)
- (12) Temporary text files are given names and deleted when closed. (See test CE3112A.)
- (13) More than one internal file can be associated with each external file for sequential files when reading only. (See tests CE2107A..E (5 tests), CE2102L, CE2110B, and CE2111D.)
- (14) More than one internal file can be associated with each external file for direct files when reading only. (See tests CE2107F..H (3 tests), CE2110D and CE2111H.)
- (15) More than one internal file can be associated with each external file for text files when reading only. (See tests CE3111A..E (5 tests), CE3114B, and CE3115A.)

## CHAPTER 3

## TEST INFORMATION

3.1 TEST RESULTS

Version 1.10 of the ACVC comprises 3717 tests. When this compiler was tested, 44 tests had been withdrawn because of test errors. The AVF determined that 342 tests were inapplicable to this implementation. All inapplicable tests were processed during validation testing except for 159 executable tests that use floating-point precision exceeding that supported by the implementation. Modifications to the code, processing, or grading for 45 tests were required to successfully demonstrate the test objective. (See section 3.6.)

The AVF concludes that the testing results demonstrate acceptable conformity to the Ada Standard.

3.2 SUMMARY OF TEST RESULTS BY CLASS

RESULT	TEST CLASS						TOTAL
	<u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>	<u>L</u>	
Passed	128	1133	1981	17	26	46	3331
Inapplicable	1	5	334	0	2	0	342
Withdrawn	1	2	35	0	6	0	44
TOTAL	130	1140	2350	17	34	46	3717

3.3 SUMMARY OF TEST RESULTS BY CHAPTER

RESULT	CHAPTER													TOTAL
	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>13</u>	<u>14</u>	
Passed	201	593	569	245	172	99	162	332	137	36	252	252	281	3331
Inapp	11	56	111	3	0	0	4	0	0	0	0	117	40	342
Withdrawn	1	1	0	0	0	0	0	2	0	0	1	35	4	44
TOTAL	213	650	680	248	172	99	166	334	137	36	253	404	325	3717



**3.4 WITHDRAWN TESTS**

The following 44 tests were withdrawn from ACVC Version 1.10 at the time of this validation:

E28005C	A39005G	B97102E
C97116A	BC3009B	CD2A62D
CD2A63A..D (4 tests)	CD2A66A..D (4 tests)	CD2A73A..D (4 tests)
CD2A76A..D (4 tests)	CD2A81G	CD2A83G
CD2A84M..N (2 tests)	CD2B15C	CD2D11B
CD5007B	CD5011O	ED7004B
ED7005C..D (2 tests)	ED7006C..D (2 tests)	CD7105A
CD7203B	CD7204B	CD7205C
CD7205D	CE2107I	CE3111C
CE3301A	CE3411B	

See Appendix D for the reason that each of these tests was withdrawn.

**3.5 INAPPLICABLE TESTS**

Some tests do not apply to all compilers because they make use of features that a compiler is not required by the Ada Standard to support. Others may depend on the result of another test that is either inapplicable or withdrawn. The applicability of a test to an implementation is considered each time a validation is attempted. A test that is inapplicable for one validation attempt is not necessarily inapplicable for a subsequent attempt. For this validation attempt, 342 tests were inapplicable for the reasons indicated:

- a. The following 159 tests are not applicable because they have floating-point type declarations requiring more digits than `SYSTEM.MAX_DIGITS`:

C24113O..Y (11 tests)	C35705O..Y (11 tests)
C35706O..Y (11 tests)	C35707O..Y (11 tests)
C35708O..Y (11 tests)	C35802O..Z (12 tests)
C45241O..Y (11 tests)	C45321O..Y (11 tests)
C45421O..Y (11 tests)	C45521O..Z (12 tests)
C45524O..Z (12 tests)	C45621O..Z (12 tests)
C45641O..Y (11 tests)	C46012O..Z (12 tests)

- b. The following 16 tests are not applicable because this implementation does not support a predefined type `LONG_INTEGER`:

C45231C	C45304C	C45502C	C45503C	C45504C
C45504F	C45611C	C45613C	C45614C	C45631C
C45632C	B52004D	C55B07A	B55B09C	B86001W
CD7101F				

- c. C45531M..P (4 tests), C45532M..P (4 tests) are not applicable because the size of a mantissa of a fixed point type is limited to 31 bits.
- d. B86001Y is not applicable because this implementation supports no predefined fixed-point type other than DURATION.
- e. B86001Z is not applicable because this implementation supports no predefined floating-point type with a name other than FLOAT, LONG\_FLOAT, or SHORT\_FLOAT.
- f. C86001F is not applicable because, for this implementation, the package TEXT\_IO is dependent upon package SYSTEM. This test redefines package SYSTEM, making package TEXT\_IO, and hence package REPORT, obsolete.
- g. CD1009C, CD2A41A..E (5 Tests) and CD2A42A..J (10 tests) are not applicable because SIZE clause on FLOAT is not supported.
- h. The following 26 tests are all inapplicable for this implementation because length clauses on a type derived from a private type are not supported outside the defining package.

CD1C04A	CD2A21C	CD2A21D	CD2A22C	CD2A22D
CD2A22G	CD2A22H	CD2A31C	CD2A31D	CD2A32C
CD2A32D	CD2A32G	CD2A32H	CD2A51C	CD2A51D
CD2A52C	CD3A52D	CE2A52G	CD2A52H	CD2A53D
CD2A54D	CD2A54H	CD2A72A	CD2A72B	CD2A75A
CD2A75B				

- i. CD1C04B, CD1C04E and CD4051A..D (4 tests) are not applicable because representation clauses on derived records or derived tasks are not supported.
- j. The following 25 tests are inapplicable because LENGTH clause on an array or record would require change of representation of the components or elements.

CD2A61A..D (4 tests)	CD2A61F
CD2A61H..L (5 tests)	CD2A62A..C (3 tests)
CD2A71A..D (4 tests)	CD2A72C..D (2 tests)
CD2A74A..D (4 tests)	CD2A75C..D (2 tests)

- k. CD2A84B..I (8 tests) and CD2A84K..L (2 tests) are not applicable because the minimum size for a 'SIZE clause applied to the access type is 32 bits.
- l. The following 30 tests are not applicable because ADDRESS clauses for constants are not supported.

CD5011B	CD5011D	CD5011F	CD5011H	CD5011L
CD5011N	CD5011R	CD5011S	CD5012C	CD5012D

---

CD5012G	CD5012H	CD5012L	CD5013B	CD5013D
CD5013F	CD5013H	CD5013L	CD5013N	CD5013R
CD5014B	CD5014D	CD5014F	CD5014H	CD5014J
CD5014L	CD5014N	CD5014R	CD5014U	CD5014W

- m. CD5012J, CD5013S and CD5014S are not applicable because ADDRESS clauses for tasks are not supported.
- n. AE2101H, EE2401D and EE2401G are instantiations of package DIRECT\_IO with unconstrained array types and record types with discriminants without defaults. These instantiations are rejected by this compiler.
- o. CE2102D is inapplicable because this implementation supports CREATE with IN\_FILE mode for SEQUENTIAL\_IO.
- p. CE2102E is inapplicable because this implementation supports CREATE with OUT\_FILE mode for SEQUENTIAL\_IO.
- q. CE2101F is inapplicable because this implementation supports CREATE with INOUT\_FILE mode for DIRECT\_IO.
- r. CE2102I is inapplicable because this implementation supports CREATE with IN\_FILE mode for DIRECT\_IO.
- s. CE2102J is inapplicable because this implementation supports CREATE with OUT\_FILE mode for DIRECT\_IO.
- t. CE2102N is inapplicable because this implementation supports OPEN with IN\_FILE mode for SEQUENTIAL\_IO.
- u. CE2102O is inapplicable because this implementation supports RESET with IN\_FILE mode for SEQUENTIAL\_IO.
- v. CE2102P is inapplicable because this implementation supports OPEN with OUT\_FILE mode for SEQUENTIAL\_IO.
- w. CE2102Q is inapplicable because this implementation supports RESET with OUT\_FILE mode for SEQUENTIAL\_IO.
- x. CE2102R is inapplicable because this implementation supports OPEN with INOUT\_FILE mode for DIRECT\_IO.
- y. CE2102S is inapplicable because this implementation supports RESET with INOUT\_FILE mode for DIRECT\_IO.
- z. CE2102T is inapplicable because this implementation supports OPEN with IN\_FILE mode for DIRECT\_IO.

- 
- aa. CE2102U, is inapplicable because this implementation supports RESET with IN\_FILE mode for DIRECT\_IO.
  - ab. CE2102V is inapplicable because this implementation supports OPEN with OUT\_FILE mode for DIRECT\_IO.
  - ac. CE2102W is inapplicable because this implementation supports RESET with OUT\_FILE mode for DIRECT\_IO.
  - ad. CE2107B..E (4 tests), CE2107L, CE2110B and CE2111D are not applicable because multiple internal files cannot be associated with the same external file when one or more files is writing for sequential files. The proper exception is raised when multiple access is attempted.
  - ae. CE2107G..H (2 tests), CE2110D and CE2111H are not applicable because multiple internal files cannot be associated with the same external file when one or more files is writing for direct files. The proper exception is raised when multiple access is attempted.
  - af. CE3102E is inapplicable because this implementation supports CREATE with IN\_FILE mode for text files.
  - ag. CE3102F is inapplicable because this implementation supports RESET for text files.
  - ah. CE3102G is inapplicable because this implementation supports deletion of an external file for text files.
  - ai. CE3102I is inapplicable because this implementation supports CREATE with OUT\_FILE mode for text files.
  - aj. CE3102J is inapplicable because this implementation supports OPEN with IN\_FILE mode for text files.
  - ak. CE3102K is inapplicable because this implementation supports OPEN with OUT\_FILE mode for text files.
  - al. CE3111B, CE3111D..E (2 tests), CE3114B and CE3115A are not applicable because multiple internal files cannot be associated with the same external file when one or more files is writing for text tiles. The proper exception is raised when multiple access is attempted.

### **3.6 TEST, PROCESSING, AND EVALUATION MODIFICATIONS**

It is expected that some tests will require modifications of code, processing, or evaluation in order to compensate for legitimate implementation behaviour. Modifications are made by the AVF in

cases where legitimate implementation behaviour prevents the successful completion of an (otherwise) applicable test. Examples of such modifications include: adding a length clause to alter the default size of a collection; splitting a Class B test into subtests so that all errors are detected; and confirming that messages produced by an executable test demonstrate conforming behaviour that was not anticipated by the test (such as raising one exception instead of another).

Modifications were required for 45 tests.

The following tests were split because syntax errors at one point resulted in the compiler not detecting other errors in the test:

B22005Z	B23004A	B24007A	B24009A	B25002A
B26005A	B27005A	B28003A	B28003C	B32202A
B32202B	B32202C	B33001A	B37004A	B45012A
B61012A	B62001B	B62001C	B62001D	B74304A
B74401F	B74401R	B91004A	B95069A	B95069B
B97103A	BA1101B	BC2001D	BC3009C	BD5005B

The following tests were split in order to show the features not supported caused errors to be raised.

CD2A62A..B (2 tests)	CD2A72A..B (2 tests)
CD2A75A..B (2 tests)	CD2A84B..I (8 tests)

EA3004D, when processed, produces only two of the expected three errors: the implementation fails to detect an error on line 27 of file EA3004D6M. This is because the pragma `INLINE` has no effect when its object is within a package specification. The task was reordered to compile files D2 and D3 after file D5 (the re-compilation of the "with"ed package that makes the various earlier units obsolete), the re-ordered test executed and produced the expected `NOT_APPLICABLE` result (as though `INLINE` were not supported at all). The re-ordering of EA3004D test files was: 0-1-4-5-2-3-6. The AVO ruled that the test should be counted as passed.

### 3.7 ADDITIONAL TESTING INFORMATION

#### 3.7.1 Prevalidation

Prior to validation, a set of test results for ACVC Version 1.10 produced by the `AlsycOMP_023` Version 4.2 was submitted to the AVF by the applicant for review. Analysis of these results demonstrated that the compiler successfully passed all applicable tests, and the compiler exhibited the expected behaviour on all inapplicable tests.

### 3.7.2 Test Method

Testing of the **AlsyCOMP\_023** using ACVC Version 1.10 was conducted on-site by a validation team from the AVF. The configuration in which the testing was performed is described by the following designations of hardware and software components:

Host computer	:	IBM 370 3084Q
Host operating system	:	MVS 3.2
Target computer	:	IBM 370 3084Q
Target operating system	:	MVS 3.2
Compiler	:	AlsyCOMP_023 Version 4.2
Pre-linker	:	AlsyCOMP_023 Version 4.2
Assembler	:	AlsyCOMP_023 Version 4.2
Linker	:	MVS 3.2
Runtime System	:	AlsyCOMP_023 Version 4.2

A magnetic tape containing all tests was taken on-site by the validation team for processing. Tests that make use of implementation-specific values were customized before being written to the magnetic tape. Tests requiring modifications during the prevalidation testing were included in their modified form on the magnetic tape.

The contents of the magnetic tape were not loaded directly onto the host computer

The whole test suite was loaded onto a VAX 11/780 and the files that required modification transferred to a SUN 3/160 computer. The modifications were then done by the UNIX ED editor and the resulting files transferred back to the VAX.

The test suite was then passed to an IBM computer via the DEC-IBM ftp software, where a tape to be read by the host machine was created.

The tape was then transferred to the host machine where the files were read in.

The host machine then proceeded to compile, bind and execute the tests with the results being transferred back to the VAX machine for printing. The procedure used to transfer the files back to the VAX machine was provided by DEC-IBM ftp software.

The compiler was tested using command scripts provided by Alsys and reviewed by the validation team. The compiler was tested using all the following option settings.

<u>OPTION</u>	<u>EFFECT</u>
<b>SOURCE =&gt; source_name</b>	expects the file 'source_file' to contain Ada source code.
<b>LIBRARY =&gt; library_name</b>	expects this to reference the Ada library
<b>ERRORS =&gt; 999</b>	maximum number of compilation errors permitted before the compiler terminates the compilation

---

<b>LEVEL =&gt; CODE</b>	a complete compilation takes place, transferring source code into object code.
<b>CHECKS =&gt; ALL</b>	all run time checks are performed.
<b>GENERICCS =&gt; INLINE</b>	places the code generic instantiations inline in the same unit as the unit that contains the instantiation.
<b>OUTPUT =&gt; filename</b>	writes the output to a file with name filename.
<b>WARNING =&gt; NO</b>	does not include the warning messages in the compilation listings.
<b>TEXT =&gt; YES</b>	prints the complete compilation listing
<b>DETAIL =&gt; YES</b>	includes detailed error messages
<b>ASSEMBLY =&gt; NONE</b>	does not include any object code or map information
<b>CALLS =&gt; NORMAL</b>	uses the normal mode for subroutine calls
<b>REDUCTION =&gt; NONE</b>	no action is taken with reference to the optimization of checks or loops
<b>OBJECT =&gt; PEEPHOLE</b>	
<b>TREE =&gt; NO</b>	does not save the abstract tree representation
<b>STACK =&gt; 1024</b>	indicate the maximum size of a stack object that can be placed in the stack segment.
<b>GLOBAL =&gt; 1024</b>	indicate the maximum size of a global object that can be placed in the stack segment.
<b>UNNESTED =&gt; 16</b>	
<b>SHOW =&gt; NONE</b>	does not include banners in the listing file.
<b>FILE_WIDTH =&gt; 80</b>	width of the listing file is 80 characters.
<b>FILE_LENGTH = NO</b>	no maximum page length given

Tests were compiled, linked, and executed (as appropriate) using a single computer. Test output, compilation listings, and job logs were captured on a magnetic tape and archived at the AVF. The listings examined on-site by the validation team were also archived.

**3.7.3 Test Site**

Testing was conducted at Alsys Limited, Partridge House, Newtown Road, Henley-on-Thames, Oxfordshire, RG9 1EN, and was completed on 20 July 1989.



## DECLARATION OF CONFORMANCE

---

### APPENDIX A

#### DECLARATION OF CONFORMANCE

**Alsys Limited** has submitted the following Declaration of Conformance concerning the **AlsyCOMP\_023** compiler. .

## DECLARATION OF CONFORMANCE

### DECLARATION OF CONFORMANCE

Compiler Implementor:      **Alsys Limited**  
                                 **Partridge House**  
                                 **Newtown Road**  
                                 **Henley-on-Thames**  
                                 **Oxfordshire      RG9 1EN**

Ada Validation Facility:      **The National Computing Centre Limited**  
                                 **Oxford Road**  
                                 **Manchester**  
                                 **M1 7ED**  
                                 **United Kingdom**


Ada Compiler Validation Capability (ACVC) Version: 1.10

#### Base Configuration

Base Compiler Name:      **AlsyCOMP\_023 version 4.2**  
Host Architecture:      **IBM 370 3084Q**  
Host OS and Version:      **MVS 3.2**  
Target Architecture:      **IBM 370 3084Q**  
Target OS and Version:      **MVS 3.2**

#### Implementor's Declaration

I, the undersigned, representing **Alsys Limited** have implemented no deliberate extensions to the Ada Language Standard ANSI/MIL-STD-1815A in the compiler(s) listed in this declaration. I declare that **Alsys Limited** is the owner of record of the Ada language compiler(s) listed above and, as such, is responsible for maintaining said compiler(s) in conformance to ANSI/MIL-STD-1815A. All certificates and registrations for Ada language compiler(s) listed in this declaration shall be made only in the owner's corporate name.

  
\_\_\_\_\_  
**Martyn Jordan**  
**Marketing Director**

Date : 18/7/89

## DECLARATION OF CONFORMANCE

---

### Owner's Declaration

I, the undersigned, representing Alsys Limited, take full responsibility for implementation and maintenance of the Ada compiler(s) listed above, and agree to the public disclosure of the final Validation Summary Report. I declare that all of the Ada language compilers listed, and their host/target performance, are in compliance with the Ada Language Standard ANSI/MIL-STD-1815A.



Date :

18/7/89

**Martyn Jordan**  
**Marketing Director**

## APPENDIX B

## APPENDIX F OF THE Ada STANDARD

The only allowed implementation dependencies correspond to implementation-dependent pragmas, to certain machine-dependent conventions as mentioned in chapter 13 of the Ada Standard, and to certain allowed restrictions on representation clauses. The implementation-dependent characteristics of the **AlsysCOMP\_023 Version 4.2** compiler, as described in this Appendix, are provided by **Alsys Limited**. Unless specifically noted otherwise, references in this appendix are to compiler documentation and not to this report. Implementation-specific portions of the package STANDARD, which are not a part of Appendix F, are:

package STANDARD is

...

type INTEGER is range -2147483648 .. 2147483647;

type SHORT\_INTEGER is range -32768 .. 32767;

type SHORT\_SHORT-INTEGER is range -128 .. 127;

type FLOAT is digits 15 range -7.24E+75 .. 7.24E+75;

type SHORT\_FLOAT is digits 6 range -7.24E+75 .. 7.24E+75;

type LONG\_FLOAT is digits 18 range -7.24E+75 .. 7.24E+75;

type DURATION is delta 2.0\*\*-14 range -86400.0 .. 86400.0;

...

end STANDARD;

**Alsys IBM 370 Ada Compiler**

**APPENDIX F**  
**for VM/CMS and MVS**  
**(including MVS/XA)**

**Implementation - Dependent Characteristics**

**Version 4.2**

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## PREFACE

This *Alsys IBM 370 Ada Compiler Appendix F* is for programmers, software engineers, project managers, educators and students who want to develop an Ada program for any IBM System/370 processor that runs VM/CMS, MVS or MVS/XA.

This appendix is a required part of the *Reference Manual for the Ada Programming Language*, ANSI/MIL-STD 1815A, January 1983 (throughout this appendix, citations in square brackets refer to this manual). It assumes that the user is already familiar with the CMS and MVS operating systems, and has access to the following IBM documents:

*CMS User Guide*, Release 3, SC19-6210

*CMS Command and Macro Reference*, Release 3, SC19-6209

*OS/VS2 MVS Overview*, GC28-0984

*OS/VS2 System Programming Library: Job Management*, GC28-1303

*MVS/370 JCL Reference*, GC28-1350

*IBM System/370 Principles of Operation*, GA22-7000

*IBM System/370 System Summary*, GA22-7001



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## APPENDIX F

### Implementation-Dependent Characteristics

This appendix summarizes the implementation-dependent characteristics of the Alsys IBM 370 Ada Compiler for VM/CMS, MVS and MVS/XA. This document should be considered as the Appendix F to the Reference Manual for the Ada Programming Language ANSI/MIL-STD 1815A, January 1983, as appropriate to the Alsys Ada implementation for the IBM 370 under VM/CMS, MVS and MVS/XA.

Sections 1 to 8 of this appendix correspond to the various items of information required in Appendix F [F]\*; sections 9 and 10 provide other information relevant to the Alsys implementation. The contents of these sections is described below:

1. The form, allowed places, and effect of every implementation-dependent pragma.
2. The name and type of every implementation-dependent attribute.
3. The specification of the package SYSTEM [13.7].
4. The list of all restrictions on representation clauses [13.1].
5. The conventions used for any implementation-generated names denoting implementation-dependent components [13.4].
6. The interpretation of expressions that appear in address clauses, including those for interrupts [13.5].
7. Any restrictions on unchecked conversions [13.10.2].
8. Any implementation-dependent characteristics of the input-output packages [14].
9. Characteristics of numeric types.
10. Other implementation-dependent characteristics.

Throughout this appendix, the name *Ada Run-Time Executive* refers to the run-time library routines provided for all Ada programs. These routines implement the Ada heap, exceptions, tasking control, I/O, and other utility functions.

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\* Throughout this manual, citations in square brackets refer to the *Reference Manual for the Ada Programming Language*, ANSI/MIL-STD-1815A, January 1983.

# 1 Implementation-Dependent Pragmas

## 1.1 INLINE

Pragma **INLINE** is fully supported, except for the fact that it is not possible to inline a function call in a declarative part.

## 1.2 INTERFACE

Ada programs can interface to subprograms written in assembler or other languages through the use of the predefined pragma **INTERFACE** [13.9] and the implementation-defined pragma **INTERFACE\_NAME**.

Pragma **INTERFACE** specifies the name of an interfaced subprogram and the name of the programming language for which calling and parameter passing conventions will be generated. Pragma **INTERFACE** takes the form specified in the *Reference Manual*:

```
pragma INTERFACE (language_name, subprogram_name);
```

where:

- *language\_name* is the name of the other language whose calling and parameter passing conventions are to be used.
- *subprogram\_name* is the name used within the Ada program to refer to the interfaced subprogram.

The only language name currently accepted by pragma **INTERFACE** is **ASSEMBLER**.

The language name used in the pragma **INTERFACE** does not necessarily correspond to the language used to write the interfaced subprogram. It is used only to tell the Compiler how to generate subprogram calls, that is, which calling conventions and parameter passing techniques to use.

The language name **ASSEMBLER** is used to refer to the standard IBM 370 calling and parameter passing conventions. The programmer can use the language name **ASSEMBLER** to interface Ada subprograms with subroutines written in any language that follows the standard IBM 370 calling conventions.

### 1.2.1 Calling Conventions

The following calling conventions are required for code to be interfaced to Ada by use of the pragma interface to **ASSEMBLER**.

The contents of the general purpose registers 12 and 13 must be restored to their original values by the interfaced code before returning to Ada.

On entry to the subprogram, register 13 contains the address of a register save area provided by the caller.

Registers 15 and 14 contain the entry point address and return address, respectively, of the called subprogram.

The Ada Run-Time Executive treats any program interruption occurring during the execution of the body of the subprogram as an exception being raised at the point of call of the subprogram. The exception raised following a program interruption in interfaced code is `NUMERIC_ERROR` for the following cases:

- Fixed-pt overflow \*
- Fixed-pt divide
- Decimal overflow \*
- Decimal divide
- Exponent overflow
- Exponent underflow \*
- Significance \*
- Floating-pt divide

In other cases, `PROGRAM_ERROR` is raised. The classes of interruptions marked with an asterisk (\*) may be masked by setting the program mask. On entry to the interfaced code exponent underflow and significance interruptions are suppressed. Note that the program mask should be restored to its original value (i.e. X'C') before returning to Ada code.

### 1.2.2 Parameter-Passing Conventions

On entry to the subprogram, register 1 contains the address of a parameter address list. Each word in this list is an address corresponding to a parameter. The last word in the list has its most significant (sign) bit set to indicate the end of the list.

For formal parameters of mode `in`, which are of scalar or access type, the address passed is that of a copy of the value of the actual parameter. For all other parameters the address passed is the address of the actual parameter itself.

Since all non-scalar and non-access parameters to interfaced subprograms are passed by address, they cannot be protected from modification by the called subprogram, even though they may be formally declared to be of mode `in`. It is the programmer's responsibility to ensure that the semantics of the Ada parameter modes are honoured in these cases.

If the address of an Ada object is passed explicitly as a parameter to an interfaced subprogram (i.e. to a formal parameter of type `SYSTEM.ADDRESS`) it is the address of the address which is passed in the parameter list: a value of type `SYSTEM.ADDRESS` being treated identically to any other scalar value.

If the subprogram is a function, register 0 is used to return the result. Scalar and access values are returned in general register 0. Floating point values are returned in floating point register 0. Non-scalar values are returned by address in general register 0.

No consistency checking is performed between the subprogram parameters declared in Ada and the corresponding parameters of the interfaced subprogram. It is the programmer's responsibility to ensure correct access to the parameters.

An example of an interfaced subprogram is:

```

* 64-bit integer addition:
*
* type DOUBLE is
*   record
*     HIGH    : INTEGER;
*     LOW     : INTEGER;
*   end record
* for DOUBLE use
*   record
*     HIGH    at 0 range 0..31;
*     LOW     at 4 range 0..31;
*   end record;
* procedure ADD (LEFT, RIGHT : in DOUBLE;
*               RESULT      : out DOUBLE);
ADD  CSECT
      USING  ADD,15
      STM    2,6,12(13)
      L      2,0(1)      Address of LEFT
      LM     3,4,0(2)    Value of LEFT
      L      2,4(1)      Address of RIGHT
      AL     4,4(2)      Add low-order components (no interruption)
      BC     12,$1       Branch if no carry
      A      3,=F'1'     Add carry (NUMERIC_ERROR possible)
$1    A      3,0(2)      Add high-order (NUMERIC_ERROR possible)
      L      2,8(1)      Address of RESULT
      STM    3,4,0(2)    Value of result
      LM     2,6,12(13)
      BR     14
      LTORG
      DROP
      END

```

### 1.2.3 Parameter Representations

This section describes the representation of values of the types that can be passed as parameters to an interfaced subprogram. The discussion assumes no representation clauses have been used to alter the default representations of the types involved. Chapter 4 describes the effect of representation clauses on the representation of values.

#### Integer Types [3.5.4]

Ada integer types are represented in two's complement form and occupy 8 (SHORT\_SHORT\_INTEGER), 16 (SHORT\_INTEGER) or 32 (INTEGER) bits.

### Enumeration Types [3.5.1]

Values of an Ada enumeration type are represented internally as unsigned values representing their position in the list of enumeration literals defining the type. The first literal in the list corresponds to a value of zero.

Enumeration types with 256 elements or fewer are represented in 8 bits, those with between 257 and 65536 ( $2^{16}$ ) elements in 16 bits and all others in 32 bits. The maximum number of values an enumeration type can include is  $2^{31}$ .

Consequently, the Ada predefined type CHARACTER [3.5.2] is represented in 8 bits, using the standard ASCII codes [C] and the Ada predefined type BOOLEAN [3.5.3] is represented in 8 bits, with FALSE represented by the value 0, and TRUE represented by the value 1.

### Floating Point Types [3.5.7, 3.5.8]

Ada floating-point values occupy 32 (SHORT\_FLOAT), 64 (FLOAT) or 128 (LONG\_FLOAT) bits, and are held in IBM 370 (short, long or extended floating point) format.

### Fixed Point Types [3.5.9, 3.5.10]

Ada fixed-point types are managed by the Compiler as the product of a signed *mantissa* and a constant *small*. The mantissa is implemented as a 16 or 32 bit integer value. *Small* is a compile-time quantity which is the power of two equal or immediately inferior to the delta specified in the declaration of the type.

The attribute MANTISSA is defined as the smallest number such that:

$$2^{**} \text{ MANTISSA} \geq \max(\text{abs}(\text{upper\_bound}), \text{abs}(\text{lower\_bound})) / \text{small}$$

The size of a fixed point type is:

MANTISSA	Size
1 .. 15	16 bits
16 .. 31	32 bits

Fixed point types requiring a MANTISSA greater than 31 are not supported.

### Access Types [3.8]

Values of access types are represented internally by the 31-bit address of the designated object held in a 32 bit word. Users should not alter any bits of this word, including those which are ignored by the architecture on which the program is running. The value zero is used to represent null.

### Array Types [3.6]

Ada arrays are passed by reference; the value passed is the address of the first element of the first dimension of the array. The elements of the array are allocated by row. When an array is passed as a parameter to an interfaced subprogram, the usual consistency checking between the array bounds declared in the calling program and the subprogram is not enforced. It is the programmer's responsibility to ensure that the subprogram does not violate the bounds of the array.

Values of the predefined type `STRING` [3.6.3] are arrays, and are passed in the same way: the address of the first character in the string is passed. Elements of a string are represented in 8 bits, using the standard ASCII codes.

### Record Types [3.7]

Ada records are passed by reference; the value passed is the address of the first component of the record. Components of a record are aligned on their natural boundaries (e.g. `INTEGER` on a word boundary) and the components may be re-ordered by the Compiler so as to minimize the total size of objects of the record type. If a record contains discriminants or components having a dynamic size, implicit components may be added to the record. Thus the default layout of the internal structure of the record may not be inferred directly from its Ada declaration. The use of a representation clause to control the layout of any record type whose values are to be passed to interfaced subprograms is recommended.

#### **1.2.4 Restrictions on Interfaced Subprograms**

The Ada Run-Time Executive uses the `SPIE` and `ESPIE` macros (SVC 14). Interfaced subprograms should avoid use of this facility, or else restore interruption processing to its original state before returning to the Ada program. Failure to do so may lead to unpredictable results.

Similarly, interfaced subprograms must not change the program mask in the Program Status Word (PSW) of the machine without restoring it before returning.

#### **1.3 INTERFACE\_NAME**

Pragma `INTERFACE_NAME` associates the name of an interfaced subprogram, as declared in Ada, with its name in the language of origin. If pragma `INTERFACE_NAME` is not used, then the two names are assumed to be identical.

This pragma takes the form:

```
pragma INTERFACE_NAME (subprogram_name, string_literal);
```

where:

- *subprogram\_name* is the name used within the Ada program to refer to the interfaced subprogram.

- *string\_literal* is the name by which the interfaced subprogram is referred to at link-time.

The use of `INTERFACE_NAME` is optional, and is not needed if a subprogram has the same name in Ada as in the language of origin. It is necessary, for example, if the name of the subprogram in its original language contains characters that are not permitted in Ada identifiers. Ada identifiers can contain only letters, digits and underscores, whereas the IBM 370 linkage editor/loader allows external names to contain other characters, e.g. the plus or minus sign. These characters can be specified in the *string\_literal* argument of the pragma `INTERFACE_NAME`.

The pragma `INTERFACE_NAME` is allowed at the same places of an Ada program as the pragma `INTERFACE` [13.9]. However, the pragma `INTERFACE_NAME` must always occur after the pragma `INTERFACE` declaration for the interfaced subprogram.

In order to conform to the naming conventions of the IBM 370 linkage editor/loader, the link-time name of an interfaced subprogram will be truncated to 8 characters and converted to upper case.

#### Example

```
package SAMPLE_DATA is
  function SAMPLE_DEVICE (X : INTEGER) return INTEGER;
  function PROCESS_SAMPLE (X : INTEGER) return INTEGER;
private
  pragma INTERFACE (ASSEMBLER, SAMPLE_DEVICE);
  pragma INTERFACE (ASSEMBLER, PROCESS_SAMPLE);
  pragma INTERFACE_NAME (PROCESS_SAMPLE, "PSAMPLE");
end SAMPLE_DATA;
```

#### 1.4 INDENT

This pragma is only used with the Alsys Reformatter (*AdaReformat*); this tool offers the functionalities of a source reformatter in an Ada environment.

The pragma is placed in the source file and interpreted by the Reformatter.

```
pragma INDENT(OFF)
```

The Reformatter does not modify the source lines after the `OFF` pragma `INDENT`.

```
pragma INDENT(ON)
```

The Reformatter resumes its action after the `ON` pragma `INDENT`. Therefore any source lines that are bracketed by the `OFF` and `ON` pragma `INDENTs` are not modified by the Alsys Reformatter.



## 1.5 RMODE

Pragma RMODE associates a residence mode with the objects designated by the access values belonging to a given access type.

This pragma takes the form:

```
pragma RMODE (access_type_name, residence_mode);
```

```
residence_mode ::= A24 | ANY
```

where :

- *access\_type\_name* is the name of the access type defining the collection of objects whose residence mode is to be specified.
- *residence\_mode* is the residence mode to be associated with the designated objects.

A24: Indicates that the designated objects must reside within 24 bit addressable virtual storage (that is, below the 16 megabyte virtual storage line under MVS/XA).

ANY: Indicates that the designated objects may reside anywhere in virtual storage (that is, either above or below the 16 megabyte virtual storage line under MVS/XA).

Under CMS or MVS on non-extended architecture machines the pragma is effectively ignored, since only 16 megabytes of virtual address space are available and all virtual addresses implicitly meet the A24 residence mode criteria.

Under MVS/XA the pragma is significant for data whose residence mode must be explicitly controlled, e.g. data which is to be passed to non-Ada code via the pragma INTERFACE.

In the absence of the pragma RMODE, the default residence mode associated with the objects designated by an access type is ANY.

The *access\_type\_name* must be a simple name. The pragma RMODE and the access type declaration to which it refers must both occur immediately within the same declarative part, package specification or task specification; the declaration must occur before the pragma.

## 1.6 MAP\_TASK

Pragma MAP\_TASK controls the mapping of Ada tasks to operating system processes. The pragma refers to a set of tasks of the same task type, all instances of which will be mapped in the same manner.

In the case of a task specification including the reserved word type, the declaration defines a task type. The set of tasks represented by such a task type name comprises all task objects of the specified type.

In the case of a task specification without the reserved word `type`, the declaration is considered to introduce an anonymous task type with a single instance [9.1]. The set of tasks represented by such an anonymous task type name comprises of exactly this one task.

This pragma takes the form:

```
pragma MAP_TASK (task_type_name, string_literal);
```

where :

- *task\_type\_name* is the name of the (anonymous) task type.
- *string\_literal* is the name by which the set of tasks of the specified task type will be referred to at bind time. This parameter is not currently used, but must be specified.

Under CMS the pragma is effectively ignored since no suitable operating system processes exist.

Under MVS the pragma controls the mapping of Ada tasks to MVS system processes. All instances of an Ada task type to which a pragma MAP\_TASK applies are mapped to their own operating system processes. Such Ada tasks never share an operating system process.

In the absence of the pragma MAP\_TASK, an Ada task is mapped to a default operating system process and internally scheduled, together with all other Ada tasks mapped to this process, by the Ada Run-Time Executive.

Pragma MAP\_TASK is allowed in the same places as a declarative item and must refer to an (anonymous) task type declared by an earlier declarative item of the same declarative part or package specification.

### 1.7 Other Pragmas

Pragmas IMPROVE and PACK are discussed in detail in the section on representation clauses (Chapter 4).

Pragma PRIORITY is accepted with the range of priorities running from 1 to 10 (see the definition of the predefined package SYSTEM in Chapter 3). The undefined priority (no pragma PRIORITY) is treated as though it were less than any defined priority value.

In addition to pragma SUPPRESS, it is possible to suppress all checks in a given compilation by the use of the Compiler option CHECKS.

The following language defined pragmas have no effect.

```
CONTROLLED  
MEMORY_SIZE  
OPTIMIZE  
STORAGE_UNIT  
SYSTEM_NAME
```

Note that all access types are implemented by default as controlled collections as described in [4.8] (see section 10.1).

## 2 Implementation-Dependent Attributes

In addition to the Representation Attributes of [13.7.2] and [13.7.3], the four attributes listed in section 5 (Conventions for Implementation-Generated Names), for use in record representation clauses, and the attributes described below are provided:

**T'DEScriptor\_SIZE** For a prefix T that denotes a type or subtype, this attribute yields the size (in bits) required to hold a descriptor for an object of the type T, allocated on the heap or written to a file. If T is constrained, T'DEScriptor\_SIZE will yield the value 0.

**T'IS\_ARRAY** For a prefix T that denotes a type or subtype, this attribute yields the value TRUE if T denotes an array type or an array subtype; otherwise, it yields the value FALSE.

### Limitations on the use of the attribute ADDRESS

The attribute ADDRESS is implemented for all prefixes that have meaningful addresses. The following entities do not have meaningful addresses and will therefore cause a compilation error if used as a prefix to ADDRESS:

- A constant or named number that is implemented as an immediate value (i.e. does not have any space allocated for it).
- A package specification that is not a library unit.
- A package body that is not a library unit or subunit.

### 3 Specification of the Package SYSTEM

```
package SYSTEM is

  type NAME is (IBM_370);

  SYSTEM_NAME : constant NAME := NAME'FIRST;
  MIN_INT     : constant := -(2**31);
  MAX_INT     : constant := 2**31-1;
  MEMORY_SIZE : constant := 2**31-1;

  type ADDRESS is range MIN_INT .. MAX_INT;

  STORAGE_UNIT : constant := 8;
  MAX_DIGITS   : constant := 18;
  MAX_MANTISSA : constant := 31;
  FINE_DELTA   : constant := 2#1.0#e-31;
  TICK         : constant := 0.01;
  NULL_ADDRESS : constant ADDRESS := 0;

  subtype PRIORITY is INTEGER range 1 .. 10;

  -- These subprograms are provided to perform
  -- READ/WRITE operations in memory.
  generic
    type ELEMENT_TYPE is private;
  function FETCH (FROM : ADDRESS) return ELEMENT_TYPE;

  generic
    type ELEMENT_TYPE is private;
  procedure STORE (INTO : ADDRESS; OBJECT : ELEMENT_TYPE);

  procedure MOVE (DEST, SOURCE : ADDRESS;
                  LENGTH      : INTEGER);

end SYSTEM;
```

The generic function `FETCH` may be used to read data objects from given addresses in store. The generic procedure `STORE` may be used to write data objects to given addresses in store.

The procedure `MOVE` may be used to move `LENGTH` bytes starting at the address `SOURCE` to the address `DEST`. The source and destination locations may overlap.

On the non-extended architecture (AMODE 24) the top byte of a value of type address is ignored (i.e. does not form part of the address). On an extended architecture (31 bit addressing) the top bit of a value of type address is similarly ignored.

## 4 Restrictions on Representation Clauses

This section explains how objects are represented and allocated by the Alsys IBM 370 Ada Compiler and how it is possible to control this using representation clauses.

The representation of an object is closely connected with its type. For this reason this section addresses successively the representation of enumeration, integer, floating point, fixed point, access, task, array and record types. For each class of type the representation of the corresponding objects is described.

Except in the case of array and record types, the description of each class of type is independent of the others. To understand the representation of an array type it is necessary to understand first the representation of its components. The same rule applies to a record type.

Apart from implementation defined pragmas, Ada provides three means to control the size of objects:

- a (predefined) pragma `PACK`, when the object is an array, an array component, a record or a record component
- a record representation clause, when the object is a record or a record component
- a size specification, in any case.

For each class of types the effect of a size specification is described. Interaction between size specifications, packing and record representation clauses is described under array and record types.

Representation clauses on derived record types or derived task types are not supported.

Size representation clauses on types derived from private types are not supported when the derived type is declared outside the private part of the defining package.

### 4.1 Enumeration Types

#### *Internal codes of enumeration literals*

When no enumeration representation clause applies to an enumeration type, the internal code associated with an enumeration literal is the position number of the enumeration literal. Then, for an enumeration type with  $n$  elements, the internal codes are the integers  $0, 1, 2, \dots, n-1$ .

An enumeration representation clause can be provided to specify the value of each internal code as described in [13.3]. The Alsys Compiler fully implements enumeration representation clauses.

As internal codes must be machine integers the internal codes provided by an enumeration representation clause must be in the range  $-2^{31} \dots 2^{31}-1$ .

### *Encoding of enumeration values*

An enumeration value is always represented by its internal code in the program generated by the Compiler.

### *Minimum size of an enumeration subtype*

The minimum size of an enumeration subtype is the minimum number of bits that is necessary for representing the internal codes of the subtype values in normal binary form.

For a static subtype, if it has a null range its minimum size is 1. Otherwise, if  $m$  and  $M$  are the values of the internal codes associated with the first and last enumeration values of the subtype, then its minimum size  $L$  is determined as follows. For  $m \geq 0$ ,  $L$  is the smallest positive integer such that  $M \leq 2^L - 1$ . For  $m < 0$ ,  $L$  is the smallest positive integer such that  $-2^{L-1} \leq m$  and  $M \leq 2^{L-1} - 1$ .

For example:

```
type COLOR is (GREEN, BLACK, WHITE, RED, BLUE, YELLOW);  
-- The minimum size of COLOR is 3 bits.
```

```
subtype BLACK_AND_WHITE is COLOR range BLACK .. WHITE;  
-- The minimum size of BLACK_AND_WHITE is 2 bits.
```

```
subtype BLACK_OR_WHITE is BLACK_AND_WHITE range X .. X;  
-- Assuming that X is not static, the minimum size of BLACK_OR_WHITE is  
-- 2 bits (the same as the minimum size of the static type mark  
-- BLACK_AND_WHITE).
```

### *Size of an enumeration subtype*

When no size specification is applied to an enumeration type or first named subtype, the objects of that type or first named subtype are represented as signed machine integers. The machine provides 8, 16 and 32 bit integers, and the Compiler selects automatically the smallest signed machine integer which can hold each of the internal codes of the enumeration type (or subtype). The size of the enumeration type and of any of its subtypes is thus 8, 16 or 32 bits.

When a size specification is applied to an enumeration type, this enumeration type and each of its subtypes has the size specified by the length clause. The same rule applies to a first named subtype. The size specification must of course specify a value greater than or equal to the minimum size of the type or subtype to which it applies.

For example:

type EXTENDED is

( -- The usual American ASCII characters.

NUL,	SOH,	STX,	ETX,	EOT,	ENQ,	ACK,	BEL,
BS,	HT,	LF,	VT,	FF,	CR,	SO,	SI,
DLE,	DC1,	DC2,	DC3,	DC4,	NAK,	SYN,	ETB,
CAN,	EM,	SUB,	ESC,	FS,	GS,	RS,	US,
' ',	'!',	'"',	'#',	'\$',	'%',	'&',	'"',
'(',	')',	'*',	'+',	'-',	'_',	'`',	'/',
'0',	'1',	'2',	'3',	'4',	'5',	'6',	'7',
'8',	'9',	'.',	':',	'<',	'=',	'>',	'?',
'@',	'A',	'B',	'C',	'D',	'E',	'F',	'G',
'H',	'I',	'J',	'K',	'L',	'M',	'N',	'O',
'P',	'Q',	'R',	'S',	'T',	'U',	'V',	'W',
'X',	'Y',	'Z',	'[',	'\',	']',	'^',	'_',
'"',	'a',	'b',	'c',	'd',	'e',	'f',	'g',
'h',	'i',	'j',	'k',	'l',	'm',	'n',	'o',
'p',	'q',	'r',	's',	't',	'u',	'v',	'w',
'x',	'y',	'z',	'{',	' ',	'}',	'~',	DEL,

-- Extended characters

LEFT\_ARROW,  
RIGHT\_ARROW,  
UPPER\_ARROW,  
LOWER\_ARROW,  
UPPER\_LEFT\_CORNER,  
UPPER\_RIGHT\_CORNER,  
LOWER\_RIGHT\_CORNER,  
LOWER\_LEFT\_CORNER,  
...);

for EXTENDED'SIZE use 8;

-- The size of type EXTENDED will be one byte. Its objects will be represented  
-- as unsigned 8 bit integers.

The Alsys Compiler fully implements size specifications. Nevertheless, as enumeration values are coded using integers, the specified length cannot be greater than 32 bits.

#### *Size of the objects of an enumeration subtype*

Provided its size is not constrained by a record component clause or a pragma PACK, an object of an enumeration subtype has the same size as its subtype.

#### *Alignment of an enumeration subtype*

An enumeration subtype is byte aligned if the size of the subtype is less than or equal to 8 bits, halfword aligned if the size of the subtype is less than or equal to 16 bits and word aligned otherwise.



### *Address of an object of an enumeration subtype*

Provided its alignment is not constrained by a record representation clause or a pragma PACK, the address of an object of an enumeration subtype is a multiple of the alignment of the corresponding subtype.

## **4.2 Integer Types**

### *Predefined integer types*

There are three predefined integer types in the Alsys implementation for IBM 370 machines:

```
type SHORT_SHORT_INTEGER is range -2**07 .. 2**07-1;
type SHORT_INTEGER       is range -2**15 .. 2**15-1;
type INTEGER              is range -2**31 .. 2**31-1;
```

### *Selection of the parent of an integer type*

An integer type declared by a declaration of the form:

```
type T is range L .. R;
```

is implicitly derived from either the SHORT\_INTEGER or INTEGER predefined integer type. The Compiler automatically selects the predefined integer type whose range is the shortest that contains the values L to R inclusive. Note that the SHORT\_SHORT\_INTEGER representation is never automatically selected by the Compiler.

### *Encoding of integer values*

Binary code is used to represent integer values. Negative numbers are represented using two's complement.

### *Minimum size of an integer subtype*

The minimum size of an integer subtype is the minimum number of bits that is necessary for representing the internal codes of the subtype values in normal binary form (that is to say, in an unbiased form which includes a sign bit only if the range of the subtype includes negative values).

For a static subtype, if it has a null range its minimum size is 1. Otherwise, if m and M are the lower and upper bounds of the subtype, then its minimum size L is determined as follows. For  $m \geq 0$ , L is the smallest positive integer such that  $M \leq 2^L - 1$ . For  $m < 0$ , L is the smallest positive integer such that  $-2^{L-1} \leq m$  and  $M \leq 2^{L-1} - 1$ .

For example:

```
subtype S is INTEGER range 0 .. 7;
-- The minimum size of S is 3 bits.

subtype D is S range X .. Y;
-- Assuming that X and Y are not static, the minimum size of
-- D is 3 bits (the same as the minimum size of the static type mark S).
```

#### *Size of an integer subtype*

The sizes of the predefined integer types `SHORT_INTEGER`, `SHORT_INTEGER` and `INTEGER` are respectively 8, 16 and 32 bits.

When no size specification is applied to an integer type or to its first named subtype (if any), its size and the size of any of its subtypes is the size of the predefined type from which it derives, directly or indirectly.

For example:

```
type S is range 80 .. 100;
-- S is derived from SHORT_INTEGER, its size is 16 bits.

type J is range 0 .. 65535;
-- J is derived from INTEGER, its size is 32 bits.

type N is new J range 80 .. 100;
-- N is indirectly derived from INTEGER, its size is 32 bits.
```

When a size specification is applied to an integer type, this integer type and each of its subtypes has the size specified by the length clause. The same rule applies to a first named subtype. The size specification must of course specify a value greater than or equal to the minimum size of the type or subtype to which it applies.

For example:

```
type S is range 80 .. 100;
for S'SIZE use 32;
-- S is derived from SHORT_INTEGER, but its size is 32 bits
-- because of the size specification.

type J is range 0 .. 255;
for J'SIZE use 8;
-- J is derived from SHORT_INTEGER, but its size is 8 bits because
-- of the size specification.

type N is new J range 80 .. 100;
-- N is indirectly derived from SHORT_INTEGER, but its size is 8 bits
-- because N inherits the size specification of J.
```

The Alsys Compiler implements size specifications. Nevertheless, as integers are implemented using machine integers, the specified length cannot be greater than 32 bits.

#### *Size of the objects of an integer subtype*

Provided its size is not constrained by a record component clause or a pragma PACK, an object of an integer subtype has the same size as its subtype.

#### *Alignment of an integer subtype*

An integer subtype is byte aligned if the size of the subtype is less than or equal to 8 bits, halfword aligned if the size of the subtype is less than or equal to 16 bits and word aligned otherwise.

#### *Address of an object of an integer subtype*

Provided its alignment is not constrained by a record representation clause or a pragma PACK, the address of an object of an integer subtype is a multiple of the alignment of the corresponding subtype.

### **4.3 Floating Point Types**

#### *Predefined floating point types*

There are three predefined floating point types in the Alsys implementation for IBM 370 machines:

```
type SHORT_FLOAT is
  digits 6 range -2.0**252*(1.0-2.0**-24) .. 2.0**252*(1.0-2.0**-24);

type FLOAT is
  digits 15 range -2.0**252*(1.0-2.0**-56) .. 2.0**252*(1.0-2.0**-56);

type LONG_FLOAT is
  digits 18 range -2.0**252*(1.0-2.0**-112) .. 2.0**252*(1.0-2.0**-112);
```

#### *Selection of the parent of a floating point type*

A floating point type declared by a declaration of the form:

```
type T is digits D [range L .. R];
```

is implicitly derived from a predefined floating point type. The Compiler automatically selects the smallest predefined floating point type whose number of digits is greater than or equal to D and which contains the values L and R.

### *Encoding of floating point values*

In the program generated by the Compiler, floating point values are represented using the IBM 370 data formats for single precision, double precision and extended precision floating point values as appropriate.

Values of the predefined type `SHORT_FLOAT` are represented using the single precision format, values of the predefined type `FLOAT` are represented using the double precision format and values of the predefined type `LONG_FLOAT` are represented using the extended precision format. The values of any other floating point type are represented in the same way as the values of the predefined type from which it derives, directly or indirectly.

### *Minimum size of a floating point subtype*

The minimum size of a floating point subtype is 32 bits if its base type is `SHORT_FLOAT` or a type derived from `SHORT_FLOAT`, 64 bits if its base type is `FLOAT` or a type derived from `FLOAT` and 128 bits if its base type is `LONG_FLOAT` or a type derived from `LONG_FLOAT`.

### *Size of a floating point subtype*

The sizes of the predefined floating point types `SHORT_FLOAT`, `FLOAT` and `LONG_FLOAT` are respectively 32, 64 and 128 bits.

The size of a floating point type and the size of any of its subtypes is the size of the predefined type from which it derives directly or indirectly.

The only size that can be specified for a floating point type or first named subtype using a size specification is its usual size (32, 64 or 128 bits).

### *Size of the objects of a floating point subtype*

An object of a floating point subtype has the same size as its subtype.

### *Alignment of a floating point subtype*

A floating point subtype is word aligned if its size is 32 bits and double word aligned otherwise.

### *Address of an object of a floating point subtype*

Provided its alignment is not constrained by a record representation clause or a pragma `PACK`, the address of an object of a floating point subtype is a multiple of the alignment of the corresponding subtype.

## 4.4 Fixed Point Types

### *Small of a fixed point type*

If no specification of small applies to a fixed point type, then the value of small is determined by the value of delta as defined by [3.5.9].

A specification of small can be used to impose a value of small. The value of small is required to be a power of two.

### *Predefined fixed point types*

To implement fixed point types, the Alsys Compiler for IBM 370 machines uses a set of anonymous predefined types of the form:

```
type FIXED is delta D range (-2**15)*S .. (2**15-1)*S;  
for FIXED'SMALL use S;
```

```
type LONG_FIXED is delta D range (-2**31)*S .. (2**31-1)*S;  
for LONG_FIXED'SMALL use S;
```

where D is any real value and S any power of two less than or equal to D.

### *Selection of the parent of a fixed point type*

A fixed point type declared by a declaration of the form:

```
type T is delta D range L .. R;
```

possibly with a small specification:

```
for T'SMALL use S;
```

is implicitly derived from a predefined fixed point type. The Compiler automatically selects the predefined fixed point type whose small and delta are the same as the small and delta of T and whose range is the shortest that includes the values L and R.

### *Encoding of fixed point values*

In the program generated by the Compiler, a safe value V of a fixed point subtype F is represented as the integer:

$$V / F\text{'BASE'SMALL}$$

### *Minimum size of a fixed point subtype*

The minimum size of a fixed point subtype is the minimum number of binary digits that is necessary for representing the values of the range of the subtype using the small of

the base type (that is to say, in an unbiased form which includes a sign bit only if the range of the subtype includes negative values).

For a static subtype, if it has a null range its minimum size is 1. Otherwise,  $s$  and  $S$  being the bounds of the subtype, if  $i$  and  $I$  are the integer representations of  $m$  and  $M$ , the smallest and the greatest model numbers of the base type such that  $s < m$  and  $M < S$ , then the minimum size  $L$  is determined as follows. For  $i \geq 0$ ,  $L$  is the smallest positive integer such that  $I \leq 2^L - 1$ . For  $i < 0$ ,  $L$  is the smallest positive integer such that  $-2^{L-1} \leq i$  and  $I \leq 2^{L-1} - 1$ .

For example:

```
type F is delta 2.0 range 0.0 .. 500.0;
-- The minimum size of F is 8 bits.
```

```
subtype S is F delta 16.0 range 0.0 .. 250.0;
-- The minimum size of S is 7 bits.
```

```
subtype D is S range X .. Y;
-- Assuming that X and Y are not static, the minimum size of D is 7 bits
-- (the same as the minimum size of its type mark S).
```

#### *Size of a fixed point subtype*

The sizes of the sets of predefined fixed point types *FIXED* and *LONG\_FIXED* are 16 and 32 bits respectively.

When no size specification is applied to a fixed point type or to its first named subtype, its size and the size of any of its subtypes is the size of the predefined type from which it derives directly or indirectly.

For example:

```
type F is delta 0.01 range 0.0 .. 2.0;
-- F is derived from a 16 bit predefined fixed type, its size is 16 bits.
```

```
type L is delta 0.01 range 0.0 .. 300.0;
-- L is derived from a 32 bit predefined fixed type, its size is 32 bits.
```

```
type N is new L range 0.0 .. 2.0;
-- N is indirectly derived from a 32 bit predefined fixed type, its size is 32 bits.
```

When a size specification is applied to a fixed point type, this fixed point type and each of its subtypes has the size specified by the length clause. The same rule applies to a first named subtype. The size specification must of course specify a value greater than or equal to the minimum size of the type or subtype to which it applies.

For example:

```
type F is delta 0.01 range 0.0 .. 2.0;
for F'SIZE use 32;
-- F is derived from a 16 bit predefined fixed type, but its size is 32 bits
-- because of the size specification.

type L is delta 0.01 range 0.0 .. 300.0;
for F'SIZE use 16;
-- F is derived from a 32 bit predefined fixed type, but its size is 16 bits
-- because of the size specification.
-- The size specification is legal since the range contains no negative values
-- and therefore no sign bit is required.

type N is new F range 0.8 .. 1.0;
-- N is indirectly derived from a 16 bit predefined fixed type, but its size is
-- 32 bits because N inherits the size specification of F.
```

The Alsys Compiler implements size specifications. Nevertheless, as fixed point objects are represented using machine integers, the specified length cannot be greater than 32 bits.

#### *Size of the objects of a fixed point subtype*

Provided its size is not constrained by a record component clause or a pragma PACK, an object of a fixed point type has the same size as its subtype.

#### *Alignment of a fixed point subtype*

A fixed point subtype is byte aligned if its size is less than or equal to 8 bits, halfword aligned if the size of the subtype is less than or equal to 16 bits and word aligned otherwise.

#### *Address of an object of a fixed point subtype*

Provided its alignment is not constrained by a record representation clause or a pragma PACK, the address of an object of a fixed point subtype is a multiple of the alignment of the corresponding subtype.

## **4.5 Access Types**

### *Collection Size*

When no specification of collection size applies to an access type, no storage space is reserved for its collection, and the value of the attribute STORAGE\_SIZE is then 0.

As described in [13.2], a specification of collection size can be provided in order to reserve storage space for the collection of an access type. The Alsys Compiler fully implements this kind of specification.

### *Encoding of access values*

Access values are machine addresses represented as 32 bit values. The implementation uses the top (most significant) bit of such a 32 bit value to pass additional information to the Ada Run-Time Executive.

### *Minimum size of an access subtype*

The minimum size of an access subtype is 32 bits.

### *Size of an access subtype*

The size of an access subtype is 32 bits, the same as its minimum size.

The only size that can be specified for an access type using a size specification is its usual size (32 bits).

### *Size of an object of an access subtype*

An object of an access subtype has the same size as its subtype, thus an object of an access subtype is always 32 bits long.

### *Alignment of an access subtype*

An access subtype is always word aligned.

### *Address of an object of an access subtype*

Provided its alignment is not constrained by a record representation clause or a pragma PACK, the address of an object of an access subtype is always on a word boundary, since its subtype is word aligned.

## **4.6 Task Types**

### *Storage for a task activation*

When no length clause is used to specify the storage space to be reserved for a task activation, the storage space indicated at bind time is used for this activation.

As described in [13.2], a length clause can be used to specify the storage space for the activation of each of the tasks of a given type. In this case the value indicated at bind time is ignored for this task type, and the length clause is obeyed.

It is not allowed to apply such a length clause to a derived type. The same storage space is reserved for the activation of a task of a derived type as for the activation of a task of the parent type.



### *Encoding of task values*

Task values are machine addresses.

### *Minimum size of a task subtype*

The minimum size of a task subtype is 32 bits.

### *Size of a task subtype*

The size of a task subtype is 32 bits, the same as its minimum size.

The only size that can be specified for a task type using a size specification is its usual size (32 bits).

### *Size of the objects of a task subtype*

An object of a task subtype has the same size as its subtype. Thus an object of a task subtype is always 32 bits long.

### *Alignment of a task subtype*

A task subtype is always word aligned.

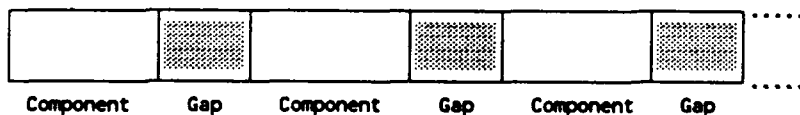
### *Address of an object of a task subtype*

Provided its alignment is not constrained by a record representation clause, the address of an object of a task subtype is always on a word boundary, since its subtype is word aligned.

## **4.7 Array Types**

### *Layout of an array*

Each array is allocated in a contiguous area of storage units. All the components have the same size. A gap may exist between two consecutive components (and after the last one). All the gaps have the same size.



### *Components*

If the array is not packed, the size of the components is the size of the subtype of the components.

For example:

```
type A is array (1 .. 8) of BOOLEAN;
-- The size of the components of A is the size of the type BOOLEAN: 8 bits.

type DECIMAL_DIGIT is range 0 .. 9;
for DECIMAL_DIGIT'SIZE use 4;
type BINARY_CODED_DECIMAL is
    array (INTEGER range <>) of DECIMAL_DIGIT;
-- The size of the type DECIMAL_DIGIT is 4 bits. Thus in an array of
-- type BINARY_CODED_DECIMAL each component will be represented in
-- 4 bits as in the usual BCD representation.
```

If the array is packed and its components are neither records nor arrays, the size of the components is the minimum size of the subtype of the components.

For example:

```
type A is array (1 .. 8) of BOOLEAN;
pragma PACK(A);
-- The size of the components of A is the minimum size of the type BOOLEAN:
-- 1 bit.

type DECIMAL_DIGIT is range 0 .. 9;
type BINARY_CODED_DECIMAL is
    array (INTEGER range <>) of DECIMAL_DIGIT;
pragma PACK(BINARY_CODED_DECIMAL);
-- The size of the type DECIMAL_DIGIT is 16 bits, but, as
-- BINARY_CODED_DECIMAL is packed, each component of an array of this
-- type will be represented in 4 bits as in the usual BCD representation.
```

Packing the array has no effect on the size of the components when the components are records or arrays.

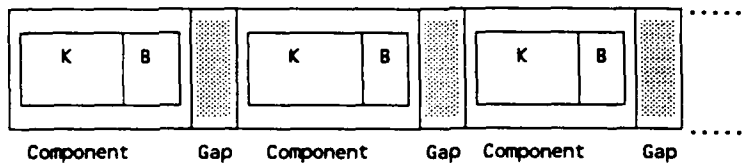
### *Gaps*

If the components are records or arrays, no size specification applies to the subtype of the components and the array is not packed, then the Compiler may choose a representation with a gap after each component; the aim of the insertion of such gaps is to optimize access to the array components and to their subcomponents. The size of the gap is chosen so that the relative displacement of consecutive components is a multiple of the alignment of the subtype of the components. This strategy allows each component and subcomponent to have an address consistent with the alignment of its subtype

For example:

```
type R is
  record
    K : INTEGER; -- INTEGER is word aligned.
    B : BOOLEAN; -- BOOLEAN is byte aligned.
  end record;
-- Record type R is word aligned. Its size is 40 bits.

type A is array (1 .. 10) of R;
-- A gap of three bytes is inserted after each component in order to respect the
-- alignment of type R. The size of an array of type A will be 640 bits.
```



*Array of type A: each subcomponent K has a word offset.*

If a size specification applies to the subtype of the components or if the array is packed, no gaps are inserted.

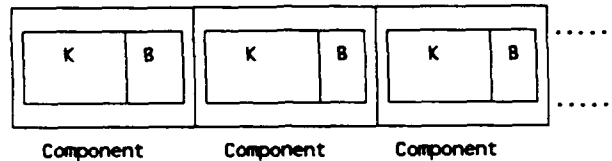
For example:

```
type R is
  record
    K : INTEGER;
    B : BOOLEAN;
  end record;

type A is array (1 .. 10) of R;
pragma PACK(A);
-- There is no gap in an array of type A because A is packed.
-- The size of an object of type A will be 400 bits.

type NR is new R;
for NR'SIZE use 40;

type B is array (1 .. 10) of NR;
-- There is no gap in an array of type B because NR has a size specification.
-- The size of an object of type B will be 400 bits.
```



*Array of type A or B: a subcomponent K can have any byte offset.*

#### *Size of an array subtype*

The size of an array subtype is obtained by multiplying the number of its components by the sum of the size of the components and the size of the gaps (if any). If the subtype is unconstrained, the maximum number of components is considered.

The size of an array subtype cannot be computed at compile time

- if it has non-static constraints or is an unconstrained array type with non-static index subtypes (because the number of components can then only be determined at run time).
- if the components are records or arrays and their constraints or the constraints of their subcomponents (if any) are not static (because the size of the components and the size of the gaps can then only be determined at run time).

As has been indicated above, the effect of a pragma PACK on an array type is to suppress the gaps and to reduce the size of the components. The consequence of packing an array type is thus to reduce its size.

If the components of an array are records or arrays and their constraints or the constraints of their subcomponents (if any) are not static, the Compiler ignores any pragma PACK applied to the array type but issues a warning message. Apart from this limitation, array packing is fully implemented by the Alsys Compiler.

The only size that can be specified for an array type or first named subtype using a size specification is its usual size. Nevertheless, such a length clause can be useful to verify that the layout of an array is as expected by the application.

#### *Size of the objects of an array subtype*

The size of an object of an array subtype is always equal to the size of the subtype of the object.

#### *Alignment of an array subtype*

If no pragma PACK applies to an array subtype and no size specification applies to its components, the array subtype has the same alignment as the subtype of its components.

If a pragma PACK applies to an array subtype or if a size specification applies to its components (so that there are no gaps), the alignment of the array subtype is the lesser of the alignment of the subtype of its components and the relative displacement of the components.

#### *Address of an object of an array subtype*

Provided its alignment is not constrained by a record representation clause, the address of an object of an array subtype is a multiple of the alignment of the corresponding subtype.

## **4.8 Record Types**

### *Layout of a record*

Each record is allocated in a contiguous area of storage units. The size of a record component depends on its type. Gaps may exist between some components.

The positions and the sizes of the components of a record type object can be controlled using a record representation clause as described in [13.4]. In the Alsys implementation for IBM 370 machines there is no restriction on the position that can be specified for a component of a record. If a component is not a record or an array, its size can be any size from the minimum size to the size of its subtype. If a component is a record or an array, its size must be the size of its subtype:

```
type ACCESS_KEY is range 0..15;
```

```
-- The size of ACCESS_KEY is 16 bits, the minimum size is 4 bits
```

```
type CONDITIONS is (ZERO, LESS_THAN, GREATER_THAN, OVERFLOW);
```

```
-- The size of CONDITIONS is 8 bits, the minimum size is 2 bits
```

```
type PROG_EXCEPTION is (FIX_OVFL, DEC_OVFL, EXP_UNDFL, SIGNIF);
```

```
type PROG_MASK is array (PROG_EXCEPTION) of BOOLEAN;
```

```
pragma PACK (PROG_MASK);
```

```
-- The size of PROG_MASK is 4 bits
```

```
type ADDRESS is range 0..2**24-1;
```

```
for ADDRESS'SIZE use 24;
```

```
-- ADDRESS represents a 24 bit memory address
```

```

type PSW is
  record
    PER_MASK      : BOOLEAN;
    DAT_MODE      : BOOLEAN;
    IO_MASK       : BOOLEAN;
    EXTERNAL_MASK : BOOLEAN;
    PSW_KEY       : ACCESS_KEY;
    EC_MODE       : BOOLEAN;
    MACHINE_CHECK : BOOLEAN;
    WAIT_STATE    : BOOLEAN;
    PROBLEM_STATE : BOOLEAN;
    ADDRESS_SPACE : BOOLEAN;
    CONDITION_CODE : CONDITIONS;
    PROGRAM_MASK  : PROG_MASK;
    INSTR_ADDRESS : ADDRESS;
  end record;
-- This type can be used to map the program status word of the IBM 370

```

```

for PSW use
  record at mod 8;
    PER_MASK      at 0 range 1..1;
    DAT_MODE      at 0 range 5..5;
    IO_MASK       at 0 range 6..6;
    EXTERNAL_MASK at 0 range 7..7;
    PSW_KEY       at 1 range 0..3;
    EC_MODE       at 1 range 4..4;
    MACHINE_CHECK at 1 range 5..5;
    WAIT_STATE    at 1 range 6..6;
    PROBLEM_STATE at 1 range 7..7;
    ADDRESS_SPACE at 2 range 0..0;
    CONDITION_CODE at 2 range 2..3;
    PROGRAM_MASK  at 2 range 4..7;
    INSTR_ADDRESS at 5 range 0..23;
  end record;

```

A record representation clause need not specify the position and the size for every component.

If no component clause applies to a component of a record, its size is the size of its subtype. Its position is chosen by the Compiler so as to optimize access to the components of the record: the offset of the component is chosen as a multiple of the alignment of the component subtype. Moreover, the Compiler chooses the position of the component so as to reduce the number of gaps and thus the size of the record objects.

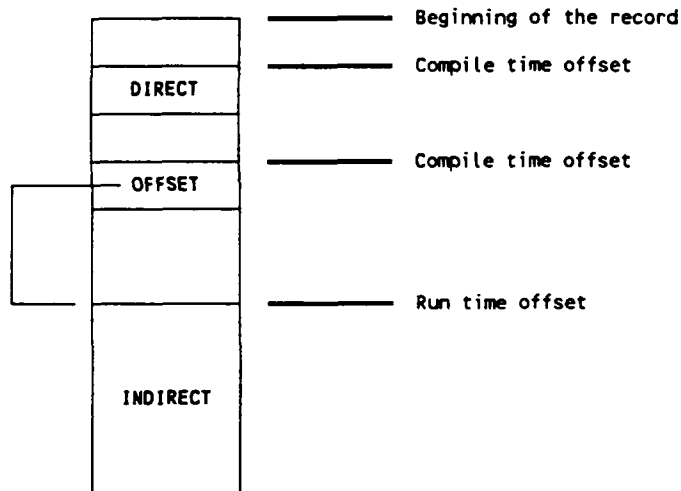
Because of these optimisations, there is no connection between the order of the components in a record type declaration and the positions chosen by the Compiler for the components in a record object.

Pragma PACK has no further effect on records. The Alsys Compiler always optimizes the layout of records as described above.

In the current version, it is not possible to apply a record representation clause to a derived type. The same storage representation is used for an object of a derived type as for an object of the parent type.

#### *Indirect components*

If the offset of a component cannot be computed at compile time, this offset is stored in the record objects at run time and used to access the component. Such a component is said to be indirect while other components are said to be direct:



*A direct and an indirect component*

If a record component is a record or an array, the size of its subtype may be evaluated at run time and may even depend on the discriminants of the record. We will call these components dynamic components.

For example:

```

type DEVICE is (SCREEN, PRINTER);

type COLOR is (GREEN, RED, BLUE);

type SERIES is array (POSITIVE range <>) of INTEGER;

type GRAPH (L : NATURAL) is
  record
    X : SERIES(1 .. L); -- The size of X depends on L
    Y : SERIES(1 .. L); -- The size of Y depends on L
  end record;

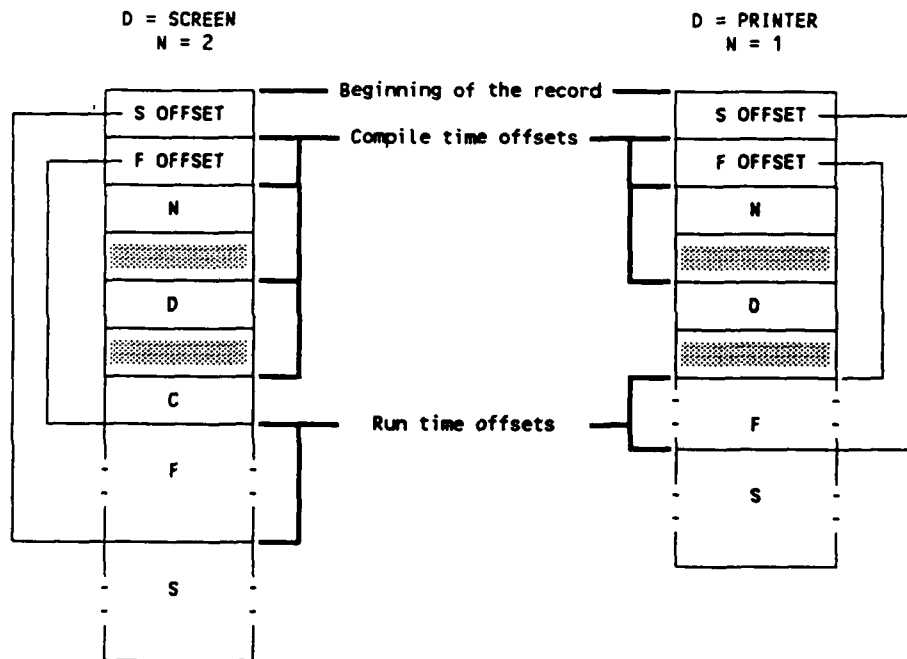
Q : POSITIVE;
```

```

type PICTURE (N : NATURAL; D : DEVICE) is
  record
    F : GRAPH(N); -- The size of F depends on N
    S : GRAPH(Q); -- The size of S depends on Q
  case D is
    when SCREEN =>
      C : COLOR;
    when PRINTER =>
      null;
  end case;
end record;

```

Any component placed after a dynamic component has an offset which cannot be evaluated at compile time and is thus indirect. In order to minimize the number of indirect components, the Compiler groups the dynamic components together and places them at the end of the record:

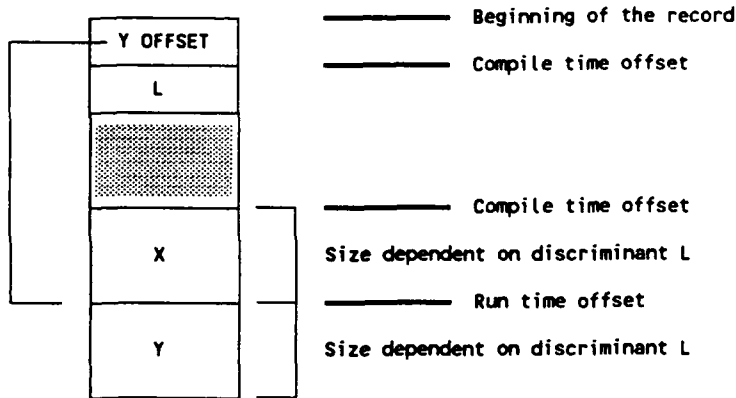


*The record type PICTURE: F and S are placed at the end of the record*

Thanks to this strategy, the only indirect components are dynamic components. But not all dynamic components are necessarily indirect: if there are dynamic components in a component list which is not followed by a variant part, then exactly one dynamic component of this list is a direct component because its offset can be computed at compilation time.



For example:



*The record type GRAPH: the dynamic component X is a direct component.*

The offset of an indirect component is always expressed in storage units.

The space reserved for the offset of an indirect component must be large enough to store the size of any value of the record type (the maximum potential offset). The Compiler evaluates an upper bound MS of this size and treats an offset as a component having an anonymous integer type whose range is 0 .. MS.

If C is the name of an indirect component, then the offset of this component can be denoted in a component clause by the implementation generated name C'OFFSET.

### *Implicit components*

In some circumstances, access to an object of a record type or to its components involves computing information which only depends on the discriminant values. To avoid useless recomputation, the Compiler stores this information in the record objects, updates it when the values of the discriminants are modified and uses it when the objects or their components are accessed. This information is stored in special components called implicit components.

An implicit component may contain information which is used when the record object or several of its components are accessed. In this case the component will be included in any record object (the implicit component is considered to be declared before any variant part in the record type declaration). There can be two components of this kind; one is called RECORD\_SIZE and the other VARIANT\_INDEX.

On the other hand an implicit component may be used to access a given record component. In this case the implicit component exists whenever the record component exists (the implicit component is considered to be declared at the same place as the record component). Components of this kind are called ARRAY\_DESCRIPTORs or RECORD\_DESCRIPTORs.

## ■ *RECORD\_SIZE*

This implicit component is created by the Compiler when the record type has a variant part and its discriminants are defaulted. It contains the size of the storage space necessary to store the current value of the record object (note that the storage effectively allocated for the record object may be more than this).

The value of a *RECORD\_SIZE* component may denote a number of bits or a number of storage units. In general it denotes a number of storage units, but if any component clause specifies that a component of the record type has an offset or a size which cannot be expressed using storage units, then the value designates a number of bits.

The implicit component *RECORD\_SIZE* must be large enough to store the maximum size of any value of the record type. The Compiler evaluates an upper bound MS of this size and then considers the implicit component as having an anonymous integer type whose range is 0 .. MS.

If R is the name of the record type, this implicit component can be denoted in a component clause by the implementation generated name R'*RECORD\_SIZE*.

## ■ *VARIANT\_INDEX*

This implicit component is created by the Compiler when the record type has a variant part. It indicates the set of components that are present in a record value. It is used when a discriminant check is to be done.

Component lists that do not contain a variant part are numbered. These numbers are the possible values of the implicit component *VARIANT\_INDEX*.

For example:

```
type VEHICLE is (AIRCRAFT, ROCKET, BOAT, CAR);
```

```
type DESCRIPTION (KIND : VEHICLE := CAR) is
```

```
  record
    SPEED : INTEGER;
    case KIND is
      when AIRCRAFT | CAR =>
        WHEELS : INTEGER;
        case KIND is
          when AIRCRAFT => -- 1
            WINGSPAN : INTEGER;
          when others => -- 2
            null;
        end case;
      when BOAT => -- 3
        STEAM : BOOLEAN;
      when ROCKET => -- 4
        STAGES : INTEGER;
    end case;
  end record;
```

The value of the variant index indicates the set of components that are present in a record value:

Variant Index	Set
1	{KIND, SPEED, WHEELS, WINGSPAN}
2	{KIND, SPEED, WHEELS}
3	{KIND, SPEED, STEAM}
4	{KIND, SPEED, STAGES}

A comparison between the variant index of a record value and the bounds of an interval is enough to check that a given component is present in the value:

Component	Interval
KIND	--
SPEED	--
WHEELS	1 .. 2
WINGSPAN	1 .. 1
STEAM	3 .. 3
STAGES	4 .. 4

The implicit component `VARIANT_INDEX` must be large enough to store the number `V` of component lists that don't contain variant parts. The Compiler treats this implicit component as having an anonymous integer type whose range is `1 .. V`.

If `R` is the name of the record type, this implicit component can be denoted in a component clause by the implementation generated name `R'VARIANT_INDEX`.

#### ■ `ARRAY_DESCRIPTOR`

An implicit component of this kind is associated by the Compiler with each record component whose subtype is an anonymous array subtype that depends on a discriminant of the record. It contains information about the component subtype.

The structure of an implicit component of kind `ARRAY_DESCRIPTOR` is not described in this documentation. Nevertheless, if a programmer is interested in specifying the location of a component of this kind using a component clause, he can obtain the size of the component using the `ASSEMBLY` parameter in the `COMPILE` command.

The Compiler treats an implicit component of the kind `ARRAY_DESCRIPTOR` as having an anonymous record type. If `C` is the name of the record component whose subtype is described by the array descriptor, then this implicit component can be denoted in a component clause by the implementation generated name `C'ARRAY_DESCRIPTOR`.

## ■ **RECORD\_DESCRIPTOR**

An implicit component of this kind is associated by the Compiler with each record component whose subtype is an anonymous record subtype that depends on a discriminant of the record. It contains information about the component subtype.

The structure of an implicit component of kind **RECORD\_DESCRIPTOR** is not described in this documentation. Nevertheless, if a programmer is interested in specifying the location of a component of this kind using a component clause, he can obtain the size of the component using the **ASSEMBLY** parameter in the **COMPILE** command.

The Compiler treats an implicit component of the kind **RECORD\_DESCRIPTOR** as having an anonymous record type. If **C** is the name of the record component whose subtype is described by the record descriptor, then this implicit component can be denoted in a component clause by the implementation generated name **C'RECORD\_DESCRIPTOR**.

### *Suppression of implicit components*

The Alsys implementation provides the capability of suppressing the implicit components **RECORD\_SIZE** and/or **VARIANT\_INDEX** from a record type. This can be done using an implementation defined pragma called **IMPROVE**. The syntax of this pragma is as follows:

```
pragma IMPROVE ( TIME | SPACE , [ON =>] simple_name );
```

The first argument specifies whether **TIME** or **SPACE** is the primary criterion for the choice of the representation of the record type that is denoted by the second argument.

If **TIME** is specified, the Compiler inserts implicit components as described above. If on the other hand **SPACE** is specified, the Compiler only inserts a **VARIANT\_INDEX** or a **RECORD\_SIZE** component if this component appears in a record representation clause that applies to the record type. A record representation clause can thus be used to keep one implicit component while suppressing the other.

A pragma **IMPROVE** that applies to a given record type can occur anywhere that a representation clause is allowed for this type.

### *Size of a record subtype*

Unless a component clause specifies that a component of a record type has an offset or a size which cannot be expressed using storage units, the size of a record subtype is rounded up to a whole number of storage units.

The size of a constrained record subtype is obtained by adding the sizes of its components and the sizes of its gaps (if any). This size is not computed at compile time

- when the record subtype has non-static constraints,
- when a component is an array or a record and its size is not computed at compile time.

The size of an unconstrained record subtype is obtained by adding the sizes of the components and the sizes of the gaps (if any) of its largest variant. If the size of a component or of a gap cannot be evaluated exactly at compile time, an upper bound of this size is used by the Compiler to compute the subtype size.

The only size that can be specified for a record type or first named subtype using a size specification is its usual size. Nevertheless, such a length clause can be useful to verify that the layout of a record is as expected by the application.

#### *Size of an object of a record subtype*

An object of a constrained record subtype has the same size as its subtype.

An object of an unconstrained record subtype has the same size as its subtype if this size is less than or equal to 8 Kbyte. If the size of the subtype is greater than this, the object has the size necessary to store its current value; storage space is allocated and released as the discriminants of the record change.

#### *Alignment of a record subtype*

When no record representation clause applies to its base type, a record subtype has the same alignment as the component with the highest alignment requirement.

When a record representation clause that does not contain an alignment clause applies to its base type, a record subtype has the same alignment as the component with the highest alignment requirement which has not been overridden by its component clause.

When a record representation clause that contains an alignment clause applies to its base type, a record subtype has an alignment that obeys the alignment clause.

#### *Address of an object of a record subtype*

Provided its alignment is not constrained by a representation clause, the address of an object of a record subtype is a multiple of the alignment of the corresponding subtype.

## 5 Conventions for Implementation-Generated Names

Special record components are introduced by the Compiler for certain record type definitions. Such record components are implementation-dependent; they are used by the Compiler to improve the quality of the generated code for certain operations on the record types. The existence of these components is established by the Compiler depending on implementation-dependent criteria. Attributes are defined for referring to them in record representation clauses. An error message is issued by the Compiler if the user refers to an implementation-dependent component that does not exist. If the implementation-dependent component exists, the Compiler checks that the storage location specified in the component clause is compatible with the treatment of this component and the storage locations of other components. An error message is issued if this check fails.

There are four such attributes:

- T'RECORD\_SIZE** For a prefix T that denotes a record type. This attribute refers to the record component introduced by the Compiler in a record to store the size of the record object. This component exists for objects of a record type with defaulted discriminants when the sizes of the record objects depend on the values of the discriminants.
- T'VARIANT\_INDEX** For a prefix T that denotes a record type. This attribute refers to the record component introduced by the Compiler in a record to assist in the efficient implementation of discriminant checks. This component exists for objects of a record type with variant type.
- C'ARRAY\_DESCRIPTOR** For a prefix C that denotes a record component of an array type whose component subtype definition depends on discriminants. This attribute refers to the record component introduced by the Compiler in a record to store information on subtypes of components that depend on discriminants.
- C'RECORD\_DESCRIPTOR** For a prefix C that denotes a record component of a record type whose component subtype definition depends on discriminants. This attribute refers to the record component introduced by the Compiler in a record to store information on subtypes of components that depend on discriminants.

## **6 Address Clauses**

### **6.1 Address Clauses for Objects**

An address clause can be used to specify an address for an object as described in [13.5]. When such a clause applies to an object no storage is allocated for it in the program generated by the Compiler. The program accesses the object using the address specified in the clause.

An address clause is not allowed for task objects, nor for unconstrained records whose size is greater than 8 Kbyte.

### **6.2 Address Clauses for Program Units**

Address clauses for program units are not implemented in the current version of the Compiler.

### **6.3 Address Clauses for Entries**

Address clauses for entries are not implemented in the current version of the Compiler.

## **7      Restrictions on Unchecked Conversions**

Unconstrained arrays are not allowed as target types.

Unconstrained record types without defaulted discriminants are not allowed as target types.

If the source and the target types are each scalar or access types, the sizes of the objects of the source and target types must be equal. If a composite type is used either as the source type or as the target type this restriction on the size does not apply.

If the source and the target types are each of scalar or access type or if they are both of composite type, the effect of the function is to return the operand.

In other cases the effect of unchecked conversion can be considered as a copy:

- if an unchecked conversion is achieved of a scalar or access source type to a composite target type, the result of the function is a copy of the source operand: the result has the size of the source.
- if an unchecked conversion is achieved of a composite source type to a scalar or access target type, the result of the function is a copy of the source operand: the result has the size of the target.



## 8 Input-Output Packages

The predefined input-output packages `SEQUENTIAL_IO` [14.2.3], `DIRECT_IO` [14.2.5], `TEXT_IO` [14.3.10] and `IO_EXCEPTIONS` [14.5] are implemented as described in the Language Reference Manual.

The package `LOW_LEVEL_IO` [14.6], which is concerned with low-level machine-dependent input-output, is not implemented.

### 8.1 NAME Parameter

#### 8.1.1 VM/CMS

The `NAME` parameter supplied to the Ada procedures `CREATE` or `OPEN` [14.2.1] may represent a CMS file name or DDNAME specified using a `FILEDEF` command.

The syntax of a CMS file name as specified in the Ada `NAME` parameter is as follows:

*file\_name* ::= *fn* [ *ft* [ *fm* ] ] | %*ddname*

where

*fn* is the CMS filename

*ft* is the CMS filetype

*fm* is the CMS filemode

If the filenames or filetypes exceed 8 characters then they are truncated. As indicated above, the filetype and filemode fields are not mandatory components of the `NAME` parameter. If the filemode is omitted, it defaults to "A1" for files being created; for files being opened, all accessed disks are searched and the CMS filemode is set to that of the first file with the appropriate filename and filetype. If, in addition, the filetype is omitted it defaults to "FILE". The case of the characters of the filename is not significant.

The `NAME` parameter may also be a DDNAME. If the file name parameter starts with a % character, the remainder of the string (excluding trailing blanks) is taken as a DDNAME previously specified using the `FILEDEF` command. If the DDNAME has not been specified using `FILEDEF`, `NAME_ERROR` will be raised.

The effect of calling `CREATE` and `DELETE` for a file opened using a DDNAME is as if `OPEN` or `CLOSE` (respectively) had been called.

#### 8.1.2 MVS

The `NAME` parameter supplied to the Ada procedures `CREATE` or `OPEN` [14.2.1] may represent an MVS dataset name or DDNAME.

The syntax of an MVS dataset name as specified in the Ada NAME parameter is as follows:

```
dataset_name ::= [&]dsname[(member)] |  
                'dsname[(member)]'|  
                %ddname
```

where

*dsname* is the MVS dataset name. If prefixed by an ampersand (&) the system assigns a temporary dataset name.

*member* is the MVS member, generation or area name.

An unqualified name (not enclosed in apostrophes) is first prefixed by the string (if any) given as the QUALIFIER parameter in the program PARM field when the program is run. An intervening period is added if required.

The QUALIFIER parameter may be specified as in the following example:

```
//STEP20 EXEC PGM=IEB73,PARM='/QUALIFIER(PAYROLL.ADA)'
```

A fully qualified name (enclosed in apostrophes) is not so prefixed. The result of the NAME function is always in the form of a fully qualified name, i.e. enclosed in single quotes.

The NAME parameter may also be a DDNAME. If the file name parameter starts with a % character, the remainder of the string (excluding trailing blanks) is taken as a DDNAME previously allocated. If the DDNAME has not been allocated, NAME\_ERROR will be raised.

The effect of calling CREATE and DELETE for a file opened using a DDNAME is as if OPEN or CLOSE (respectively) had been called.

## 8.2 FORM Parameter

The FORM parameter comprises a set of attributes formulated according to the lexical rules of [2], separated by commas. The FORM parameter may be given as a null string except when DIRECT\_IO is instantiated with an unconstrained type; in this case the RECORD\_SIZE attribute must be provided. Attributes are comma-separated; blanks may be inserted between lexical elements as desired. In the descriptions below the meanings of *natural*, *positive*, etc., are as in Ada; attribute keywords (represented in upper case) are identifiers [2.3] and as such may be specified without regard to case.

USE\_ERROR is raised if the FORM parameter does not conform to these rules.

The attributes are as follows:

#### File sharing attribute

This attribute allows control over the sharing of one external file between several internal files within a single program. In effect it establishes rules for subsequent OPEN and CREATE calls which specify the same external file. If such rules are violated or if a different file sharing attribute is specified in a later OPEN or CREATE call, `USE_ERROR` will be raised. The syntax is as follows:

```
NOT_SHARED |  
SHARED => access_mode
```

where

```
access_mode ::= READERS | SINGLE_WRITER | ANY
```

A file sharing attribute of:

`NOT_SHARED`

implies only one internal file may access the external file.

`SHARED => READERS`

imposes no restrictions on internal files of mode `IN_FILE`, but prevents any internal files of mode `OUT_FILE` or `INOUT_FILE` being associated with the external file.

`SHARED => SINGLE_WRITER`

is as `SHARED => READERS`, but in addition allows a single internal file of mode `OUT_FILE` or `INOUT_FILE`.

`SHARED => ANY`

places no restrictions on external file sharing.

If a file of the same name has previously been opened or created, the default is taken from that file's sharing attribute, otherwise the default depends on the mode of the file: for mode `IN_FILE` the default is `SHARED => READERS`, for modes `INOUT_FILE` and `OUT_FILE` the default is `NOT_SHARED`.

#### Record format attribute

This attribute controls the record format (RECFM) of an external file created in Ada. The attribute may only be used in the `FORM` parameter of the `CREATE` command; if used in the `FORM` parameter of the `OPEN` command, `USE_ERROR` will be raised.

By default, files are created according to the following rules:

- for TEXT\_IO, and instantiations of SEQUENTIAL\_IO of unconstrained types, variable-length record files (RECFM = V) are created.
- for DIRECT\_IO, and instantiations of SEQUENTIAL\_IO of constrained types, fixed-length record files (RECFM = F) are created.

The syntax of the record format attribute is as follows:

RECFM => V | F

#### Record size attribute

This attribute controls the logical record length (LRECL) of an external file created in Ada. The attribute may only be used in the FORM parameter of the CREATE command; if used in the FORM parameter of the OPEN command, USE\_ERROR will be raised.

In the case of RECFM F files (see record format attribute) the record size attribute specifies the record length of each record; in the case of RECFM V files, the record size attribute specifies the maximum record length.

In the case of DIRECT\_IO.CREATE for unconstrained types the user is required to specify the RECORD\_SIZE attribute (otherwise USE\_ERROR will be raised by the OPEN or CREATE procedures).

In the case of DIRECT\_IO and SEQUENTIAL\_IO for constrained types the value given must not be smaller than ELEMENT\_TYPE'SIZE / SYSTEM.STORAGE\_UNIT; USE\_ERROR will be raised if this rule is violated.

In the case of DIRECT\_IO and SEQUENTIAL\_IO for unconstrained types the value given must not be smaller than ELEMENT\_TYPE'DESRIPTOR\_SIZE / SYSTEM.STORAGE\_UNIT plus the size of the largest record which is to be read or written. If a larger record is processed, DATA\_ERROR will be raised by the READ or WRITE.

In the case of TEXT\_IO, output lines will be padded to the requisite length with spaces; this fact should be borne in mind when re-reading files generated using TEXT\_IO with the record size attribute set.

The syntax of the record size attribute is as follows:

RECORD\_SIZE | LRECL => *natural*

where *natural* is a size in bytes.

For input-output of constrained types the default is:

RECORD\_SIZE => *element\_length*

where

$$element\_length = ELEMENT\_TYPE'SIZE / SYSTEM.STORAGE\_UNIT$$

For input-output of unconstrained types other than via `DIRECT_IO`, in which case the `RECORD_SIZE` attribute must be provided by the user, variable size records are used (`RECFM V`).

#### Block size attribute

This attribute controls the block size of an external file. The block size must be at least as large as the record size (if specified) or must obey the same rules for specifying the record size.

The default is

$$BLOCK\_SIZE \Rightarrow record\_size$$

for `RECFM F` files and

$$BLOCK\_SIZE \Rightarrow 4096$$

for `RECFM V` files.

#### Carriage control

This attribute applies to `TEXT_IO` only, and is intended for files destined to be sent to a printer.

For a file of mode `OUT_FILE`, this attribute causes the output procedures of `TEXT_IO` to place a carriage control character as the first character of every output record; '1' (skip to channel 1) if the record follows a page terminator, or space (skip to next line) otherwise. Subsequent characters are output as normal as the result of calls of the output subprograms of `TEXT_IO`.

For a file of mode `IN_FILE`, this attribute causes the input procedures of `TEXT_IO` to interpret the first character of each record as a carriage control character, as described in the previous paragraph. Carriage control characters are not explicitly returned as a result of an input subprogram, but will (for example) affect the result of `END_OF_PAGE`.

The user should naturally be careful to ensure the carriage control attribute of a file of mode `IN_FILE` has the same value as that specified when creating the file.

The syntax of the carriage control attribute is as follows:

$$CARRIAGE\_CONTROL [ \Rightarrow boolean ]$$

For CMS files, the default is set according to the filetype of the file: if the filetype is `LISTING`, the default is `CARRIAGE_CONTROL => TRUE` otherwise the default is

CARRIAGE\_CONTROL => FALSE. If the attribute alone is specified without a boolean value it is set to TRUE.

### Truncate

This attribute applies to TEXT\_IO files of mode IN\_FILE, and causes the input procedures of TEXT\_IO to remove trailing blanks from records read.

The syntax of the TRUNCATE attribute is as follows:

TRUNCATE [ => *boolean* ]

The default is TRUNCATE => FALSE.

Note that truncation is always performed for TEXT\_IO files for which the record size attribute is set (i.e. RECFM = F). If the attribute alone is specified without a boolean value it is set to TRUE.

### Append

This attribute may only be used in the FORM parameter of the OPEN command; if used in the FORM parameter of the CREATE command, USE\_ERROR will be raised.

The affect of this attribute is to cause writing to commence at the end of the existing file.

The syntax of the APPEND attribute is as follows:

APPEND [ => *boolean* ]

The default is APPEND => FALSE. If the attribute alone is specified without a boolean value it is set to TRUE.

### Eof string

This attribute applies only to files associated with the terminal opened using TEXT\_IO, and controls the logical *end\_of\_file* string. If a line equal to the logical *end\_of\_file* string is typed in, END\_OF\_FILE will become TRUE. If an attempt is made to read from a file for which END\_OF\_FILE is TRUE, END\_ERROR will be raised.

The syntax of the EOF\_STRING attribute is as follows:

EOF\_STRING => *sequence\_of\_characters*

The default is EOF\_STRING => /\*

The EOF\_STRING may not contain commas or spaces.

If the `END_OF_FILE` function is called, a "look-ahead read" will be required. This means that (for example) a question-and-answer session at the terminal coded as follows:

```
while not END_OF_FILE loop
  PUT_LINE ("Enter value:");
  GET_LINE ( ... );
end loop;
```

will cause the prompt to appear only after the first value has been input. If the example is recoded without the explicit call to `END_OF_FILE` (but perhaps within a handler for `END_ERROR`) the behaviour will be appropriate.

### 8.2.1 MVS specific FORM attributes

The following additional FORM parameter attributes apply only to programs run under MVS.

#### Unit attribute

This attribute allows control over the unit on which a file is allocated. The syntax is as follows:

`UNIT => unit_name`

where *unit\_name* specifies a group name, a device type or a specific unit address.

The default is the local installation specific default.

#### Volume attribute

This attribute allows control over the volume on which a file is allocated. The syntax is as follows:

`VOLUME => volume_name`

where *volume\_name* specifies the volume serial number.

The default is the local installation specific default.

#### Primary attribute

This attribute allows control over the primary space allocation for a file. The syntax is as follows:

`PRIMARY => natural`

where *natural* is the number of blocks allocated to the file.

The default is the local installation specific default.

### Secondary attribute

This attribute allows control over the secondary space allocation for a file. The syntax is as follows:

**SECONDARY => *natural***

where *natural* is the number of additional blocks allocated to the file if more space is needed.

The default is the local installation specific default.

## **8.3 STANDARD\_INPUT and STANDARD\_OUTPUT**

The Ada internal files STANDARD\_INPUT and STANDARD\_OUTPUT are associated with the external files %ADAIN and %ADAOUT, respectively. By default under CMS the DDNAMEs ADAIN and ADAOUT are defined to be the terminal, but the user may redefine their assignments using the FILEDEF command before running any program. Under MVS, the DDNAMEs must be allocated before any program is run, whether or not the corresponding Ada internal files are used.

## **8.4 USE\_ERROR**

The following conditions will cause USE\_ERROR to be raised:

- Specifying a FORM parameter whose syntax does not conform to the rules given above.
- Specifying the EOF\_STRING FORM parameter attribute for files other than TEXT\_IO files of mode IN\_FILE.
- Specifying the CARRIAGE\_CONTROL FORM parameter attribute for files other than TEXT\_IO files.
- Specifying the BLOCK\_SIZE FORM parameter attribute to have a value less than RECORD\_SIZE.
- Specifying the RECORD\_SIZE FORM parameter attribute to have a value of zero, or failing to specify RECORD\_SIZE for instantiations of DIRECT\_IO for unconstrained types.
- Specifying a RECORD\_SIZE FORM parameter attribute to have a value less than that required to hold the element for instantiations of DIRECT\_IO and SEQUENTIAL\_IO for constrained types.
- Violating the file sharing rules stated above.
- For CMS, attempting to write a zero length record to other than the terminal.



- Errors detected whilst reading or writing (e.g. writing to a file on a read-only disk).

## 8.5 Text Terminators

Line terminators [14.3] are not implemented using a character, but are implied by the end of physical record.

Page terminators [14.3] are implemented using the EBCDIC character 0C (hexadecimal).

File terminators [14.3] are not implemented using a character, but are implied by the end of physical file. Note that for terminal input a line consisting of the EQF\_STRING (see 8.1.1) is interpreted as a file terminator. Thus, entering such a line to satisfy a read from the terminal will raise the END\_ERROR exception.

The user should avoid the explicit output of the character ASCII.FF [C], as this will not cause a page break to be emitted. If the user explicitly outputs the character ASCII.LF, this is treated as a call of NEW\_LINE [14.3.4].

The following characters have special meaning for VM/SP; this should be borne in mind when reading from the display terminal:

<u>Character</u>	<u>Default VM/SP meaning</u>	<u>May be changed using</u>
#	logical line end symbol	CP TERMINAL LINEND
"	logical escape character	CP TERMINAL ESCAPE
@	logical character delete symbol	CP TERMINAL CHARDEL

## 8.6 EBCDIC and ASCII

All I/O using TEXT\_IO is performed using ASCII/EBCDIC translation. CHARACTER and STRING values are held internally in ASCII but represented in external files in EBCDIC. For SEQUENTIAL\_IO and DIRECT\_IO no translation takes place, and the external file contains a binary image of the internal representation of the Ada element (see section 8.7).

It should be noted that the EBCDIC character set is larger than the (7 bit) ASCII and that the use of EBCDIC and ASCII control characters may not produce the desired results when using TEXT\_IO (the input and output of control characters is in any case not defined by the Ada language [14.3]). Furthermore, the user is advised to exercise caution in the use of BAR (!) and SHARP (#), which are part of the lexis of Ada; if their use is prevented by translation between ASCII and EBCDIC, EXCLAM (!) and COLON (:), respectively, should be used instead [2.10].

Various translation tables exist to translate between ASCII and EBCDIC. The predefined package EBCDIC is provided to allow access to the translation facilities used by TEXT\_IO and SYSTEM\_ENVIRONMENT (see *Character Code Translation Tables* in the *Compiler User's Guide*).

The specification of this package is given in section 10.5.1.

## **8.7 Characteristics of Disk Files**

A disk file that has already been created and is opened takes on the characteristics that are already associated with that file.

The characteristics of disk files that are created using the predefined input-output packages are set up as described below.

### **8.7.1 TEXT\_IO**

- A carriage control character is placed in column 1 if the carriage control attribute is specified in the FORM parameter.
- Data is translated between ASCII and EBCDIC so that the external file is readable using other System/370 tools.
- Under MVS, TEXT\_IO files are implemented as DSORG PS (QSAM) datasets.

### **8.7.2 SEQUENTIAL\_IO**

- No translation is performed between ASCII and EBCDIC; the data in the external file is a memory image of the elements written, preceded by a descriptor in the case of unconstrained types.
- Under MVS, SEQUENTIAL\_IO files are implemented as DSORG PS (QSAM) datasets.

### **8.7.3 DIRECT\_IO**

- No translation is performed between ASCII and EBCDIC; the data in the external file is a memory image of the elements written, preceded by a descriptor in the case of unconstrained types.
- Under CMS DIRECT\_IO files may be read using SEQUENTIAL\_IO (and vice-versa if a RECORD\_SIZE component is specified).
- Under MVS, DIRECT\_IO files are implemented as DSORG DA (BDAM) datasets.

## 9 Characteristics of Numeric Types

### 9.1 Integer Types

The ranges of values for integer types declared in package STANDARD are as follows:

SHORT_SHORT_INTEGER	-128 .. 127	-- $-2^{**7} .. 2^{**7} - 1$
SHORT_INTEGER	-32768 .. 32767	-- $-2^{**15} .. 2^{**15} - 1$
INTEGER	-2147483648 .. 2147483647	-- $-2^{**31} .. 2^{**31} - 1$

For the packages DIRECT\_IO and TEXT\_IO, the ranges of values for types COUNT and POSITIVE\_COUNT are as follows:

COUNT	0 .. 2147483647	-- $0 .. 2^{**31} - 1$
POSITIVE_COUNT	1 .. 2147483647	-- $1 .. 2^{**31} - 1$

For the package TEXT\_IO, the range of values for the type FIELD is as follows:

FIELD	0 .. 255	-- $0 .. 2^{**8} - 1$
-------	----------	-----------------------

### 9.2 Floating Point Type Attributes

#### SHORT\_FLOAT

		Approximate value
DIGITS	6	
MANTISSA	21	
EMAX	84	
EPSILON	$2.0^{**} -20$	9.54E-07
SMALL	$2.0^{**} -85$	2.58E-26
LARGE	$2.0^{**} 84 * (1.0 - 2.0^{**} -21)$	1.93E+25
SAFE_EMAX	252	
SAFE_SMALL	$2.0^{**} -253$	6.91E-77
SAFE_LARGE	$2.0^{**} 252 * (1.0 - 2.0^{**} -21)$	7.24E+75
FIRST	$-2.0^{**} 252 * (1.0 - 2.0^{**} -24)$	-7.24E+75
LAST	$2.0^{**} 252 * (1.0 - 2.0^{**} -24)$	7.24E+75
MACHINE_RADIX	16	
MACHINE_MANTISSA	6	
MACHINE_EMAX	63	
MACHINE_EMIN	-64	
MACHINE_ROUNDS	FALSE	
MACHINE_OVERFLOWS	TRUE	
SIZE	32	

## FLOAT

		Approximate value
DIGITS	15	
MANTISSA	51	
EMAX	204	
EPSILON	$2.0^{** -50}$	8.88E-16
SMALL	$2.0^{** -205}$	1.94E-62
LARGE	$2.0^{** 204} * (1.0 - 2.0^{** -51})$	2.57E+61
SAFE_EMAX	252	
SAFE_SMALL	$2.0^{** -253}$	6.91E-77
SAFE_LARGE	$2.0^{** 252} * (1.0 - 2.0^{** -51})$	7.24E+75
FIRST	$-2.0^{** 252} * (1.0 - 2.0^{** -56})$	-7.24E+75
LAST	$2.0^{** 252} * (1.0 - 2.0^{** -56})$	7.24E+75
MACHINE_RADIX	16	
MACHINE_MANTISSA	14	
MACHINE_EMAX	63	
MACHINE_EMIN	-64	
MACHINE_ROUNDS	FALSE	
MACHINE_OVERFLOWS	TRUE	
SIZE	64	

## LONG\_FLOAT

		Approximate value
DIGITS	18	
MANTISSA	61	
EMAX	244	
EPSILON	$2.0^{** -60}$	8.67E-19
SMALL	$2.0^{** -245}$	1.77E-74
LARGE	$2.0^{** 244} * (1.0 - 2.0^{** -61})$	2.83E+73
SAFE_EMAX	252	
SAFE_SMALL	$2.0^{** -253}$	6.91E-77
SAFE_LARGE	$2.0^{** 252} * (1.0 - 2.0^{** -61})$	7.24E+75
FIRST	$-2.0^{** 252} * (1.0 - 2.0^{** -112})$	-7.24E+75
LAST	$2.0^{** 252} * (1.0 - 2.0^{** -112})$	7.24E+75
MACHINE_RADIX	16	
MACHINE_MANTISSA	28	
MACHINE_EMAX	63	
MACHINE_EMIN	-64	
MACHINE_ROUNDS	FALSE	
MACHINE_OVERFLOWS	TRUE	
SIZE	128	

### 9.3 Attributes of Type DURATION

DURATION'DELTA	2.0 ** -14
DURATION'SMALL	2.0 ** -14
DURATION'LARGE	131072.0
DURATION'FIRST	-86400.0
DURATION'LAST	86400.0

## 10 Other Implementation-Dependent Characteristics

### 10.1 Characteristics of the Heap

All objects created by allocators go into the program heap. In addition, portions of the Ada Run-Time Executive's representation of task objects, including the task stacks, are allocated in the program heap.

All objects on the heap belonging to a given collection have their storage reclaimed on exit from the innermost block statement, subprogram body or task body that encloses the access type declaration associated with the collection. For access types declared at the library level, this deallocation occurs only on completion of the main program.

There is no further automatic storage reclamation performed, i.e. in effect, all access types are deemed to be controlled [4.8]. The explicit deallocation of the object designated by an access value can be achieved by calling an appropriate instantiation of the generic procedure `UNCHECKED_DEALLOCATION`.

Space for the heap is initially claimed from the system on program start up and additional space may be claimed as required when the initial allocation is exhausted. The size of both the initial allocation and the size of the individual increments claimed from the system may be controlled by the Binder options `SIZE` and `INCREMENT`. Corresponding run-time options also exist.

On an extended architecture machine space allocated from the program heap may be above or below the 16 megabyte virtual storage line. The implementation defined pragma `RMODE` (see section 1.4) is provided to control the residence mode of objects allocated from the program heap.

### 10.2 Characteristics of Tasks

The default initial task stack size is 16 Kbytes, but by using the Binder option `TASK` the size for all task stacks in a program may be set to any size from 4 Kbytes to 16 Mbytes. A corresponding run-time option also exists.

If a task stack becomes exhausted during execution, it is automatically extended using storage claimed from the heap. The `TASK` option specifies the minimum size of such an extension, i.e. the task stack is extended by the size actually required or by the value of the `TASK` option, whichever is the larger.

Timeslicing is implemented for task scheduling. The default time slice is 1000 milliseconds, but by using the Binder option `SLICE` the time slice may be set to any multiple of 10 milliseconds. A corresponding run-time option also exists. It is also possible to use this option to specify no timeslicing, i.e. tasks are scheduled only at explicit synchronisation points. Timeslicing is started only upon activation of the first task in the program, so the `SLICE` option has no effect for sequential programs.

Normal priority rules are followed for preemption, where `PRIORITY` values run in the range 1 .. 10. All tasks with "undefined" priority (no pragma `PRIORITY`) are considered to have a priority of 0.

The minimum timeable delay is 10 milliseconds.

The maximum number of active tasks is limited only by memory usage. Tasks release their storage allocation as soon as they have terminated.

The acceptor of a rendezvous executes the accept body code in its own stack. A rendezvous with an empty accept body (e.g. for synchronisation) need not cause a context switch.

The main program waits for completion of all tasks dependent on library packages before terminating. Such tasks may select a terminate alternative only after completion of the main program.

Abnormal completion of an aborted task takes place immediately, except when the abnormal task is the caller of an entry that is engaged in a rendezvous. Any such task becomes abnormally completed as soon as the rendezvous is completed.

If a global deadlock situation arises because every task (including the main program) is waiting for another task, the program is aborted and the state of all tasks is displayed.

### **10.3 Definition of a Main Program**

A main program must be a non-generic, parameterless, library procedure.

### **10.4 Ordering of Compilation Units**

The Alsys IBM 370 Ada Compiler imposes no additional ordering constraints on compilations beyond those required by the language.

### **10.5 Implementation Defined Packages**

The following packages are defined by the Alsys Ada implementation for the IBM 370 under VM/CMS and MVS

#### **10.5.1 Package EBCDIC**

The implementation-defined package EBCDIC provides the user with access to the ASCII to EBCDIC and EBCDIC to ASCII translation facilities used by the TEXT\_IO, SYSTEM\_ENVIRONMENT and RECORD\_IO packages.

The specification of package EBCDIC is as follows:

package EBCDIC is

```
type EBCDIC_CHARACTER is (  
    nul,          -- 0 = 0h  
    soh,          -- 1 = 1h  
    stx,          -- 2 = 2h  
    etx,          -- 3 = 3h  
    E_4,  
    ht,          -- 5 = 5h  
    E_6,  
    del,         -- 7 = 7h  
    E_8,  
    E_9,  
    E_A,  
    vt,          -- 11 = 08h  
    np,          -- 12 = 0Ch  
    cr,          -- 13 = 0Dh  
    so,          -- 14 = 0Eh  
    si,          -- 15 = 0Fh  
    dle,         -- 16 = 10h  
    dc1,         -- 17 = 11h  
    dc2,         -- 18 = 12h  
    dc3,         -- 19 = 13h  
    E_14,  
    nl,          -- 21 = 15h  
    bs,          -- 22 = 16h  
    E_17,  
    can,         -- 24 = 18h  
    em,          -- 25 = 19h  
    E_1A,  
    E_1B,  
    E_1C,  
    gs,          -- 29 = 10h  
    rs,          -- 30 = 1Eh  
    us,          -- 31 = 1Fh  
    E_20,  
    E_21,  
    fs,          -- 34 = 22h  
    E_23,  
    E_24,  
    E_25,  
    etb,         -- 38 = 26h  
    esc,         -- 39 = 27h  
    E_28,  
    E_29,  
    E_2A,  
    E_2B,  
    E_2C,  
    enq,         -- 45 = 20h  
    ack,         -- 46 = 2Eh
```



```

bel,          -- 47 = 2Fh
E_30,
E_31,
syn,          -- 50 = 32h
E_33,
E_34,
E_35,
E_36,
eot,          -- 55 = 37h
E_38,
E_39,
E_3A,
E_3B,
dc4,          -- 60 = 3Ch
nak,          -- 61 = 3Dh
E_3E,
sub,          -- 63 = 3Fh
' ',          -- 64 = 40h
E_41,
E_42,
E_43,
E_44,
E_45,
E_46,
E_47,
E_48,
E_49,
E_4A,
'!',          -- 75 = 48h
'<',         -- 76 = 4Ch
'(',          -- 77 = 4Dh
'+',          -- 78 = 4Eh
'|',          -- 79 = 4Fh
'&',          -- 80 = 50h
E_51,
E_52,
E_53,
E_54,
E_55,
E_56,
E_57,
E_58,
E_59,
'!',          -- 90 = 5Ah
'$',          -- 91 = 5Bh
'*',          -- 92 = 5Ch
')',          -- 93 = 5Dh
';',          -- 94 = 5Eh
':',          -- 95 = 5Fh
'-',          -- 96 = 60h
'/',          -- 97 = 61h
E_62,
E_63,

```

E_64,	
E_65,	
E_66,	
E_67,	
E_68,	
E_69,	
E_6A,	
' ',	--107 = 68h
'X',	--108 = 6Ch
'_',	--109 = 6Dh
'>',	--110 = 6Eh
'?',	--111 = 6Fh
E_70,	
E_71,	
E_72,	
E_73,	
E_74,	
E_75,	
E_76,	
E_77,	
E_78,	
'!',	--121 = 79h
':',	--122 = 7Ah
'#',	--123 = 7Bh
'@',	--124 = 7Ch
'''',	--125 = 7Dh
'=',	--126 = 7Eh
''''',	--127 = 7Fh
E_80,	
'a',	--129 = 81h
'b',	--130 = 82h
'c',	--131 = 83h
'd',	--132 = 84h
'e',	--133 = 85h
'f',	--134 = 86h
'g',	--135 = 87h
'h',	--136 = 88h
'i',	--137 = 89h
E_8A,	
E_8B,	
E_8C,	
E_8D,	
E_8E,	
E_8F,	
E_90,	
'j',	--145 = 91h
'k',	--146 = 92h
'l',	--147 = 93h
'm',	--148 = 94h
'n',	--149 = 95h
'o',	--150 = 96h
'p',	--151 = 97h
'q',	--152 = 98h

'r',	--153 = 99h
E_9A,	
E_9B,	
E_9C,	
E_9D,	
E_9E,	
E_9F,	
E_A0,	
'-',	--161 = 0A1h
's',	--162 = 0A2h
't',	--163 = 0A3h
'u',	--164 = 0A4h
'v',	--165 = 0A5h
'w',	--166 = 0A6h
'x',	--167 = 0A7h
'y',	--168 = 0A8h
'z',	--169 = 0A9h
E_AA,	
E_AB,	
E_AC,	
'[',	--173 = 0ADh
E_AE,	
E_AF,	
E_B0,	
E_B1,	
E_B2,	
E_B3,	
E_B4,	
E_B5,	
E_B6,	
E_B7,	
E_B8,	
E_B9,	
E_BA,	
E_BB,	
E_BC,	
']',	--189 = 0BDh
E_BE,	
E_BF,	
'(',	--192 = 0C0h
'A',	--193 = 0C1h
'B',	--194 = 0C2h
'C',	--195 = 0C3h
'D',	--196 = 0C4h
'E',	--197 = 0C5h
'F',	--198 = 0C6h
'G',	--199 = 0C7h
'H',	--200 = 0C8h
'I',	--201 = 0C9h
E_CA,	
E_CB,	
E_CC,	
E_CD,	

```

E_CE,
E_CF,
'I',      --208 = 000h
'J',      --209 = 001h
'K',      --210 = 002h
'L',      --211 = 003h
'M',      --212 = 004h
'N',      --213 = 005h
'O',      --214 = 006h
'P',      --215 = 007h
'Q',      --216 = 008h
'R',      --217 = 009h
E_DA,
E_DB,
E_DC,
E_DD,
E_DE,
E_DF,
'\',      --224 = 0E0h
E_E1,
'S',      --226 = 0E2h
'T',      --227 = 0E3h
'U',      --228 = 0E4h
'V',      --229 = 0E5h
'W',      --230 = 0E6h
'X',      --231 = 0E7h
'Y',      --232 = 0E8h
'Z',      --233 = 0E9h
E_EA,
E_EB,
E_EC,
E_ED,
E_EE,
E_EF,
'O',      --240 = 0F0h
'1',      --241 = 0F1h
'2',      --242 = 0F2h
'3',      --243 = 0F3h
'4',      --244 = 0F4h
'5',      --245 = 0F5h
'6',      --246 = 0F6h
'7',      --247 = 0F7h
'8',      --248 = 0F8h
'9',      --249 = 0F9h
E_FA,
E_FB,
E_FC,
E_FD,
E_FE,
E_FF);

```

```

SEL : constant EBCDIC_CHARACTER := E_4;
RNL : constant EBCDIC_CHARACTER := E_6;

```

```

GE      : constant EBCDIC_CHARACTER := E_8;
SPS     : constant EBCDIC_CHARACTER := E_9;
RPT     : constant EBCDIC_CHARACTER := E_A;
RES     : constant EBCDIC_CHARACTER := E_4;
ENP     : constant EBCDIC_CHARACTER := E_4;
POC     : constant EBCDIC_CHARACTER := E_17;
UBS     : constant EBCDIC_CHARACTER := E_1A;
CU1     : constant EBCDIC_CHARACTER := E_1B;
IFS     : constant EBCDIC_CHARACTER := E_1C;
DS      : constant EBCDIC_CHARACTER := E_20;
SOS     : constant EBCDIC_CHARACTER := E_21;
WJS     : constant EBCDIC_CHARACTER := E_23;
BYP     : constant EBCDIC_CHARACTER := E_24;
INP     : constant EBCDIC_CHARACTER := E_24;
LF      : constant EBCDIC_CHARACTER := E_25;
SA      : constant EBCDIC_CHARACTER := E_28;
SFE     : constant EBCDIC_CHARACTER := E_29;
SM      : constant EBCDIC_CHARACTER := E_2A;
SW      : constant EBCDIC_CHARACTER := E_2A;
CSP     : constant EBCDIC_CHARACTER := E_2B;
MFA     : constant EBCDIC_CHARACTER := E_2C;
IR      : constant EBCDIC_CHARACTER := E_33;
PP      : constant EBCDIC_CHARACTER := E_34;
TRN     : constant EBCDIC_CHARACTER := E_35;
NBS     : constant EBCDIC_CHARACTER := E_36;
SBS     : constant EBCDIC_CHARACTER := E_38;
IT      : constant EBCDIC_CHARACTER := E_39;
RFF     : constant EBCDIC_CHARACTER := E_3A;
CU3     : constant EBCDIC_CHARACTER := E_3B;
SP      : constant EBCDIC_CHARACTER := ' ';
RSP     : constant EBCDIC_CHARACTER := E_41;
CENT    : constant EBCDIC_CHARACTER := E_4A;
SHY     : constant EBCDIC_CHARACTER := E_CA;
HOOK    : constant EBCDIC_CHARACTER := E_CC;
FORK    : constant EBCDIC_CHARACTER := E_CE;
NSP     : constant EBCDIC_CHARACTER := E_E1;
CHAIR   : constant EBCDIC_CHARACTER := E_EC;
EO      : constant EBCDIC_CHARACTER := E_FF;
E_0     : constant EBCDIC_CHARACTER := nul;
E_1     : constant EBCDIC_CHARACTER := soh;
E_2     : constant EBCDIC_CHARACTER := stx;
E_3     : constant EBCDIC_CHARACTER := etx;
E_5     : constant EBCDIC_CHARACTER := ht;
E_7     : constant EBCDIC_CHARACTER := del;
E_8     : constant EBCDIC_CHARACTER := vt;
E_C     : constant EBCDIC_CHARACTER := np;
E_D     : constant EBCDIC_CHARACTER := cr;
E_E     : constant EBCDIC_CHARACTER := so;
E_F     : constant EBCDIC_CHARACTER := si;
E_10    : constant EBCDIC_CHARACTER := dle;
E_11    : constant EBCDIC_CHARACTER := dc1;
E_12    : constant EBCDIC_CHARACTER := dc2;
E_13    : constant EBCDIC_CHARACTER := dc3;

```

```

E_15 : constant EBCDIC_CHARACTER := nl;
E_16 : constant EBCDIC_CHARACTER := bs;
E_18 : constant EBCDIC_CHARACTER := can;
E_19 : constant EBCDIC_CHARACTER := em;
E_1D : constant EBCDIC_CHARACTER := gs;
E_1E : constant EBCDIC_CHARACTER := rs;
E_1F : constant EBCDIC_CHARACTER := us;
E_22 : constant EBCDIC_CHARACTER := fs;
E_26 : constant EBCDIC_CHARACTER := etb;
E_27 : constant EBCDIC_CHARACTER := esc;
E_2D : constant EBCDIC_CHARACTER := enq;
E_2E : constant EBCDIC_CHARACTER := ack;
E_2F : constant EBCDIC_CHARACTER := bel;
E_32 : constant EBCDIC_CHARACTER := syn;
E_37 : constant EBCDIC_CHARACTER := eot;
E_3C : constant EBCDIC_CHARACTER := dc4;
E_3D : constant EBCDIC_CHARACTER := nak;
E_3F : constant EBCDIC_CHARACTER := sub;
E_40 : constant EBCDIC_CHARACTER := ' ';
E_4B : constant EBCDIC_CHARACTER := ' ';
E_4C : constant EBCDIC_CHARACTER := '<';
E_4D : constant EBCDIC_CHARACTER := '(':
E_4E : constant EBCDIC_CHARACTER := '+';
E_4F : constant EBCDIC_CHARACTER := '|';
E_50 : constant EBCDIC_CHARACTER := '&';
E_5A : constant EBCDIC_CHARACTER := '!';
E_5B : constant EBCDIC_CHARACTER := '$';
E_5C : constant EBCDIC_CHARACTER := '*';
E_5D : constant EBCDIC_CHARACTER := ')';
E_5E : constant EBCDIC_CHARACTER := ',';
E_5F : constant EBCDIC_CHARACTER := '-'';
E_60 : constant EBCDIC_CHARACTER := '-';
E_61 : constant EBCDIC_CHARACTER := '/';
E_68 : constant EBCDIC_CHARACTER := ',';
E_6C : constant EBCDIC_CHARACTER := '%';
E_6D : constant EBCDIC_CHARACTER := '_';
E_6E : constant EBCDIC_CHARACTER := '>';
E_6F : constant EBCDIC_CHARACTER := '?';
E_79 : constant EBCDIC_CHARACTER := '`';
E_7A : constant EBCDIC_CHARACTER := ':';
E_7B : constant EBCDIC_CHARACTER := '#';
E_7C : constant EBCDIC_CHARACTER := '@';
E_7D : constant EBCDIC_CHARACTER := '!';
E_7E : constant EBCDIC_CHARACTER := '=';
E_7F : constant EBCDIC_CHARACTER := '~';
E_81 : constant EBCDIC_CHARACTER := 'a';
E_82 : constant EBCDIC_CHARACTER := 'b';
E_83 : constant EBCDIC_CHARACTER := 'c';
E_84 : constant EBCDIC_CHARACTER := 'd';
E_85 : constant EBCDIC_CHARACTER := 'e';
E_86 : constant EBCDIC_CHARACTER := 'f';
E_87 : constant EBCDIC_CHARACTER := 'g';
E_88 : constant EBCDIC_CHARACTER := 'h';

```

```

E_89 : constant EBCDIC_CHARACTER := 'i';
E_91 : constant EBCDIC_CHARACTER := 'j';
E_92 : constant EBCDIC_CHARACTER := 'k';
E_93 : constant EBCDIC_CHARACTER := 'l';
E_94 : constant EBCDIC_CHARACTER := 'm';
E_95 : constant EBCDIC_CHARACTER := 'n';
E_96 : constant EBCDIC_CHARACTER := 'o';
E_97 : constant EBCDIC_CHARACTER := 'p';
E_98 : constant EBCDIC_CHARACTER := 'q';
E_99 : constant EBCDIC_CHARACTER := 'r';
E_A1 : constant EBCDIC_CHARACTER := 's';
E_A2 : constant EBCDIC_CHARACTER := 't';
E_A3 : constant EBCDIC_CHARACTER := 'u';
E_A4 : constant EBCDIC_CHARACTER := 'v';
E_A5 : constant EBCDIC_CHARACTER := 'w';
E_A6 : constant EBCDIC_CHARACTER := 'x';
E_A7 : constant EBCDIC_CHARACTER := 'y';
E_A8 : constant EBCDIC_CHARACTER := 'z';
E_AD : constant EBCDIC_CHARACTER := '[';
E_B0 : constant EBCDIC_CHARACTER := ']';
E_C0 : constant EBCDIC_CHARACTER := '^';
E_C1 : constant EBCDIC_CHARACTER := '_';
E_C2 : constant EBCDIC_CHARACTER := '`';
E_C3 : constant EBCDIC_CHARACTER := 'a';
E_C4 : constant EBCDIC_CHARACTER := 'b';
E_C5 : constant EBCDIC_CHARACTER := 'c';
E_C6 : constant EBCDIC_CHARACTER := 'd';
E_C7 : constant EBCDIC_CHARACTER := 'e';
E_C8 : constant EBCDIC_CHARACTER := 'f';
E_C9 : constant EBCDIC_CHARACTER := 'g';
E_D0 : constant EBCDIC_CHARACTER := 'h';
E_D1 : constant EBCDIC_CHARACTER := 'i';
E_D2 : constant EBCDIC_CHARACTER := 'j';
E_D3 : constant EBCDIC_CHARACTER := 'k';
E_D4 : constant EBCDIC_CHARACTER := 'l';
E_D5 : constant EBCDIC_CHARACTER := 'm';
E_D6 : constant EBCDIC_CHARACTER := 'n';
E_D7 : constant EBCDIC_CHARACTER := 'o';
E_D8 : constant EBCDIC_CHARACTER := 'p';
E_D9 : constant EBCDIC_CHARACTER := 'q';
E_E0 : constant EBCDIC_CHARACTER := 'r';
E_E2 : constant EBCDIC_CHARACTER := 's';
E_E3 : constant EBCDIC_CHARACTER := 't';
E_E4 : constant EBCDIC_CHARACTER := 'u';
E_E5 : constant EBCDIC_CHARACTER := 'v';
E_E6 : constant EBCDIC_CHARACTER := 'w';
E_E7 : constant EBCDIC_CHARACTER := 'x';
E_E8 : constant EBCDIC_CHARACTER := 'y';
E_E9 : constant EBCDIC_CHARACTER := 'z';
E_F0 : constant EBCDIC_CHARACTER := '0';
E_F1 : constant EBCDIC_CHARACTER := '1';
E_F2 : constant EBCDIC_CHARACTER := '2';

```

```

E_F3 : constant EBCDIC_CHARACTER := '3';
E_F4 : constant EBCDIC_CHARACTER := '4';
E_F5 : constant EBCDIC_CHARACTER := '5';
E_F6 : constant EBCDIC_CHARACTER := '6';
E_F7 : constant EBCDIC_CHARACTER := '7';
E_F8 : constant EBCDIC_CHARACTER := '8';
E_F9 : constant EBCDIC_CHARACTER := '9';

type EBCDIC_STRING is array (POSITIVE range <>) of EBCDIC_CHARACTER;

function ASCII_TO_EBCDIC (S : STRING) return EBCDIC_STRING;
function ASCII_TO_EBCDIC (C : CHARACTER) return EBCDIC_CHARACTER;

-- CONSTRAINT_ERROR is raised if E_STRING'LENGTH /= A_STRING'LENGTH;
procedure ASCII_TO_EBCDIC (A_STRING : in STRING;
                           E_STRING : out EBCDIC_STRING);

function EBCDIC_TO_ASCII (S : EBCDIC_STRING) return STRING;
function EBCDIC_TO_ASCII (C : EBCDIC_CHARACTER) return CHARACTER;

-- CONSTRAINT_ERROR is raised if E_STRING'LENGTH /= A_STRING'LENGTH;
procedure EBCDIC_TO_ASCII (E_STRING : in EBCDIC_STRING;
                           A_STRING : out STRING);

end EBCDIC;

```

## **EBCDIC\_CHARACTER**

The type **EBCDIC\_CHARACTER** provides an Ada character type [3.5.2] following the EBCDIC character set encoding.

## **EBCDIC\_STRING**

The type **EBCDIC\_STRING** provides a one dimensional array of the type **EBCDIC\_CHARACTER**, indexed by values of the predefined type **POSITIVE**.

**EBCDIC\_STRING** implements strings of **EBCDIC\_CHARACTER** in the same way that the predefined type **STRING** implements strings of the predefined type **CHARACTER**.

In many ways **EBCDIC\_STRING**s may be manipulated exactly as the predefined type **STRING**; in particular, string literals and concatenations are available.

## **ASCII\_TO\_EBCDIC**

The subprograms **ASCII\_TO\_EBCDIC** convert ASCII encoded data to EBCDIC encoded data.



## **EBCDIC\_TO\_ASCII**

The subprograms EBCDIC\_TO\_ASCII convert EBCDIC encoded data to ASCII encoded data.

The procedures ASCII\_TO\_EBCDIC and EBCDIC\_TO\_ASCII are much more efficient than the corresponding functions, as they do not make use of the program heap. If the *in* and *out* string parameters are of different lengths (i.e. A\_STRING'LENGTH /= E\_STRING'LENGTH), the procedures will raise the exception CONSTRAINT\_ERROR.

The user may alter the ASCII to EBCDIC and EBCDIC to ASCII mappings used by the Alsys IBM 370 Ada Compiler, as described in the *Installation Guides*.

### 10.5.2 Package GENERIC\_ELEMENTARY\_FUNCTIONS

The generic package `GENERIC_ELEMENTARY_FUNCTIONS` provides the user with the elementary mathematical functions denoted by: `SQRT`, `EXP`, `**`, `LOG`, `SIN`, `COS`, `TAN`, `COT`, `ARCSIN`, `ARCCOS`, `ARCTAN`, `SINH`, `COSH` and `TANH`. The generic parameter specifies the type of the arguments and results of the mathematical functions.

The package `GENERIC_ELEMENTARY_FUNCTIONS` provides an Ada interface to the facilities of the VS FORTRAN mathematical library, which must be available before programs calling the subprograms of `GENERIC_ELEMENTARY_FUNCTIONS` may be linked.

Under CMS, the VS FORTRAN mathematical library is `VFORTLIB` `TXTLIB`, which is made available using the CMS `GLOBAL` command:

```
GLOBAL TXTLIB VFORTLIB
```

Under MVS, the VS FORTRAN mathematical library is `SYS1.VFORTLIB`, which may be concatenated with the `SYSLIB DD` statement of the linkage editor or loader jobstep.

Linking an Ada program which calls any of the subprograms of `GENERIC_ELEMENTARY_FUNCTIONS` will then automatically cause the appropriate routines of the VS FORTRAN mathematical library to be included.

The specification of package `GENERIC_ELEMENTARY_FUNCTIONS` is as follows:

```
with MATHEMATICAL_EXCEPTIONS;
generic
  type FLOAT_TYPE is digits <>;
package GENERIC_ELEMENTARY_FUNCTIONS is

  function SQRT (X : FLOAT_TYPE) return FLOAT_TYPE;
  -- Computes the square root of X.
  -- The exception ARGUMENT_ERROR is raised if a negative argument is given.

  function EXP (X : FLOAT_TYPE) return FLOAT_TYPE;
  -- Computes the exponential of X ( e to the X ).
  -- The exception CONSTRAINT_ERROR is raised if the result value is too big.

  function "**" (X,Y : FLOAT_TYPE) return FLOAT_TYPE;
  -- Computes X to the power Y.
  -- The exception ARGUMENT_ERROR is raised if X < 0.0
  -- or ( X = 0.0 and Y < 0.0 ) .
  -- The exception CONSTRAINT_ERROR is raised if the result value is too big.

  function LOG (X : FLOAT_TYPE) return FLOAT_TYPE;
  -- Computes the natural logarithm of X.
  -- The exception ARGUMENT_ERROR is raised if X is non-positive.
  -- The exception CONSTRAINT_ERROR is raised if the result value is too big.

  function SIN (X : FLOAT_TYPE) return FLOAT_TYPE;
  -- Computes the sine of X expressed in radians.
```

```

function COS (X : FLOAT_TYPE) return FLOAT_TYPE;
-- Computes the cosine of X expressed in radians.

function TAN (X : FLOAT_TYPE) return FLOAT_TYPE;
-- Computes the tangent of X expressed in radians.
-- The exception CONSTRAINT_ERROR is raised if the result value is too big.

function COT (X : FLOAT_TYPE) return FLOAT_TYPE;
-- Computes the cotangent of X expressed in radians.
-- The exception CONSTRAINT_ERROR is raised if the result value is too big.

function ARCSIN (X : FLOAT_TYPE) return FLOAT_TYPE;
-- Computes the arc sine of X.
-- The exception ARGUMENT_ERROR is raised if X not in -1.0 .. 1.0 .

function ARCCOS (X : FLOAT_TYPE) return FLOAT_TYPE;
-- Computes the arc cosine of X.
-- The exception ARGUMENT_ERROR is raised if X not in -1.0 .. 1.0 .

function ARCTAN (X : FLOAT_TYPE) return FLOAT_TYPE;
-- Computes the arc tangent of X.

function ARCTAN (Y,X : FLOAT_TYPE) return FLOAT_TYPE;
-- Computes the angle between the positive x_axis and the directed line
-- segment from the origin to the point (X,Y).
-- The exception ARGUMENT_ERROR is raised for the origin (0.0,0.0).

function SINH (X : FLOAT_TYPE) return FLOAT_TYPE;
-- Computes the hyperbolic sine of X.
-- The exception CONSTRAINT_ERROR is raised if the result value is too big.

function COSH (X : FLOAT_TYPE) return FLOAT_TYPE;
-- Computes the hyperbolic cosine of X.
-- The exception CONSTRAINT_ERROR is raised if the result value is too big.

function TANH (X : FLOAT_TYPE) return FLOAT_TYPE;
-- Computes the hyperbolic tangent of X.

```

```

ARGUMENT_ERROR : exception renames MATHEMATICAL_EXCEPTIONS.ARGUMENT_ERROR;

```

```

end GENERIC_ELEMENTARY_FUNCTIONS;

```

The exception `MATHEMATICAL_EXCEPTIONS.ARGUMENT_ERROR` is renamed as `ARGUMENT_ERROR` in the package specification and is raised when the parameter value is outside the argument domain of the relevant function.

The specification of the package `MATHEMATICAL_EXCEPTIONS` is as below:

```

package MATHEMATICAL_EXCEPTIONS is
    ARGUMENT_ERROR : exception;
end MATHEMATICAL_EXCEPTIONS;

```

The predefined exception `CONSTRAINT_ERROR` is raised when the absolute value of the result of the function is too large (i.e. is outside the range of the base type of the actual type).

FUNCTION	ARGUMENT DOMAIN	POSSIBLE EXCEPTION
<code>SQRT (X)</code>	<code>FLOAT_TYPE</code> with $X \geq 0.0$	<code>ARGUMENT_ERROR</code>
<code>EXP (X)</code>	<code>FLOAT_TYPE</code>	<code>CONSTRAINT_ERROR</code>
<code>** (X, Y)</code>	<code>FLOAT_TYPE</code> with $X > 0.0$ or ( $X = 0.0$ and $Y > 0.0$ )	<code>ARGUMENT_ERROR</code> or <code>CONSTRAINT_ERROR</code>
<code>LOG (X)</code>	<code>FLOAT_TYPE</code> with $X > 0.0$	<code>ARGUMENT_ERROR</code> or <code>CONSTRAINT_ERROR</code>
<code>SIN (X)</code>	<code>FLOAT_TYPE</code>	
<code>COS (X)</code>	<code>FLOAT_TYPE</code>	
<code>TAN (X)</code>	<code>FLOAT_TYPE</code>	<code>CONSTRAINT_ERROR</code>
<code>COT (X)</code>	<code>FLOAT_TYPE</code>	<code>CONSTRAINT_ERROR</code>
<code>ASIN (X)</code>	<code>FLOAT_TYPE</code> range $-1.0 .. 1.0$	<code>ARGUMENT_ERROR</code>
<code>ARCCOS (X)</code>	<code>FLOAT_TYPE</code> range $-1.0 .. 1.0$	<code>ARGUMENT_ERROR</code>
<code>ARCTAN (X)</code>	<code>FLOAT_TYPE</code>	
<code>ARCTAN (Y, X)</code>	<code>FLOAT_TYPE</code> except $(0.0, 0.0)$	<code>ARGUMENT_ERROR</code>
<code>SINH (X)</code>	<code>FLOAT_TYPE</code>	<code>CONSTRAINT_ERROR</code>
<code>COSH (X)</code>	<code>FLOAT_TYPE</code>	<code>CONSTRAINT_ERROR</code>
<code>TANH (X)</code>	<code>FLOAT_TYPE</code>	

An example of a possible use of the generic elementary mathematical library is given below:

```
with GENERIC_ELEMENTARY_FUNCTIONS;
package POLAR_COORDINATES is

    type MY_REAL is digits 5;
    package MY_MATH_FUNCTIONS is new GENERIC_ELEMENTARY_FUNCTIONS (FLOAT_TYPE => MY_REAL);

    function MODULUS (X,Y : MY_REAL) return MY_REAL;
    function PHASE    (X,Y : MY_REAL) return MY_REAL;

end POLAR_COORDINATES;

package body POLAR_COORDINATES is

    function MODULUS (X,Y : MY_REAL) return MY_REAL is

        A,B : MY_REAL;
    begin
        if abs X > abs Y then
            A := abs X;
            B := abs Y;
        else
            A := abs Y;
            B := abs X;
        end if;

        if A > 0.0 then
            return A * MY_MATH_FUNCTIONS.SQRT (1.0+(B/A)**2);
        else
            return 0.0;
        end if;
    end MODULUS;

    function PHASE (X,Y : MY_REAL) return MY_REAL is
    begin
        return MY_MATH_FUNCTIONS.ARCTAN (X,Y);
    end PHASE;

end POLAR_COORDINATES;
```

### 10.5.3 Package SYSTEM\_ENVIRONMENT

The specification of package SYSTEM\_ENVIRONMENT is as follows:

package SYSTEM\_ENVIRONMENT is

```
MVS : constant BOOLEAN := boolean_value;
CMS : constant BOOLEAN := not MVS;

subtype EXIT_STATUS is INTEGER;
type STACK_MODE is (LIFO, FIFO);

function ARG_LINE return STRING;
procedure ARG_LINE (LINE : out STRING;
                    LAST : out NATURAL);
function ARG_LINE_LENGTH return NATURAL;
function ARG_START return POSITIVE;
function ARG_COUNT return NATURAL;
function ARG_VALUE (INDEX : in POSITIVE) return STRING;
ARGUMENT_ERROR : exception;

procedure SET_EXIT_STATUS (STATUS : in EXIT_STATUS);
function GET_EXIT_STATUS return EXIT_STATUS;

function LOAD (PROGRAM : in STRING) return SYSTEM_ADDRESS;
function UNLOAD (PROGRAM : in STRING) return EXIT_STATUS;
function CALL (EP : in SYSTEM_ADDRESS;
               ARG_LINE : in STRING := "") return EXIT_STATUS;
procedure CALL (EP : in SYSTEM_ADDRESS;
               ARG_LINE : in STRING := "");
function EXECUTE (PROGRAM : in STRING;
                 ARG_LINE : in STRING := "") return EXIT_STATUS;
procedure EXECUTE (PROGRAM : in STRING;
                 ARG_LINE : in STRING := "");
function EXECUTE_COMMAND (COMMAND : in STRING) return EXIT_STATUS;
procedure EXECUTE_COMMAND (COMMAND : in STRING);

procedure STACK (COMMAND : in STRING;
                MODE : in STACK_MODE := LIFO);
function SENTRIES return NATURAL;

procedure ABORT_PROGRAM (STATUS : in EXIT_STATUS);

function SYSTIME return DURATION;
function USRTIME return DURATION;

function EXISTS (FILE : in STRING) return BOOLEAN;
function LAST_EXCEPTION_NAME return STRING;

end SYSTEM_ENVIRONMENT;
```

## **MVS**

The boolean constant has the value TRUE under MVS or MVS/XA and FALSE under VM/CMS.

## **CMS**

The CMS boolean provides a convenient way for a user to query at run time whether a program is running under VM/CMS. This facility allows for the conditional execution of operating system specific code.

The boolean constant has the value TRUE under VM/CMS and FALSE under MVS or MVS/XA.

## **ARG\_LINE**

The ARG\_LINE subprograms give access to the CMS command line, the TSO command line parameters or the program PARM string as specified in the JCL used to run an MVS program.

The procedure ARG\_LINE is more efficient than the corresponding function, as it does not make use of the program heap. The out parameter LAST specifies the character in LINE which holds the last character of the command line. Note, if LINE is not long enough to hold the command line given, CONSTRAINT\_ERROR will be raised.

Under CMS the command line returned includes the name of the program executed, but not any run-time options specified.

Under MVS the name of the program executed is not available, but any run-time options specified are excluded, as under CMS.

## **ARG\_START**

The ARG\_START function returns the index in the command line of the first parameter, i.e. ignoring the executed program name, for CMS; for MVS it always returns the value 1.

## **ARG\_COUNT**

The ARG\_COUNT function returns the number of parameters in the command line of the program. The executed program name which is part of the command line as returned by ARG\_LINE under CMS is not included in the count. Thus, ARG\_COUNT for a program without parameters returns zero under both CMS and MVS.

## **ARG\_VALUE**

The function ARG\_VALUE returns the specified parameter from the command line. Parameters are considered to be indexed from 1. The executed program name which is

part of the command line as returned by ARG\_LINE under CMS is not considered as a parameter, i.e. ARG\_VALUE(1) returns the first user parameter. The exception ARGUMENT\_ERROR is raised if the specified index is greater than ARG\_COUNT.

## SET\_EXIT\_STATUS

The exit status of the program (returned in register 15 on exit) can be set by a call of SET\_EXIT\_STATUS. Subsequent calls of SET\_EXIT\_STATUS will modify the exit status; the status finally returned being that specified by the last executed call to SET\_EXIT\_STATUS. If SET\_EXIT\_STATUS is not called, a positive exit code may be set by the Ada Run-Time Executive if an unhandled exception is propagated out of the main subprogram, or if a deadlock situation is detected, otherwise the value 0 is returned.

The following exit codes relate to unhandled exceptions:

Exception	Code	Cause of exception
NUMERIC_ERROR:	1	divide by zero
	2	numeric overflow
CONSTRAINT_ERROR:	3	discriminant error
	4	lower bound index error
	5	upper bound index error
	6	length error
	7	lower bound range error
	8	upper bound range error
	9	null access value
STORAGE_ERROR:	10	frame overflow (overflow on subprogram entry)
	11	stack overflow (overflow otherwise)
	12	heap overflow
PROGRAM_ERROR:	13	access before elaboration
	14	function left without return
SPURIOUS_ERROR:	15-20	<an erroneous program>
NUMERIC_ERROR:	21	(other than for the above reasons)
CONSTRAINT_ERROR:	22	(other than for the above reasons)
	23	anonymously raised exception (an exception re-raised using the raise statement without an exception name)
	24	<unused>
	25	explicitly raised exception

Code 100 is used if a deadlocking situation is detected and the program is aborted as a result.



Codes 1000-1999 are used to indicate other anomalous conditions in the initialisation of the program, messages concerning which are displayed on the terminal.

## **GET\_EXIT\_STATUS**

The GET\_EXIT\_STATUS function returns the current exit status.

## **LOAD**

Under CMS the LOAD function brings the specified text file (containing relocatable object code) into virtual storage, performing required relocations as it does so. The function returns the entry address of the loaded program if the load is successful, otherwise the calling program will be abnormally terminated.

Under MVS the LOAD function brings the load module containing the specified entry name into virtual storage, performing required relocations as it does so. The function returns the entry address of the loaded program if the load is successful, otherwise the value SYSTEM.NULL\_ADDRESS is returned.

## **UNLOAD**

The UNLOAD function cancels the effect of a previous call to the LOAD function. The PROGRAM parameter passed to the UNLOAD function must be the same as the PROGRAM parameter passed to the corresponding call to the LOAD function.

Any program brought into virtual storage by the LOAD function will not be removed until a corresponding call to the UNLOAD function is made or until the end of the loading program is reached.

The result of the UNLOAD function is an EXIT\_STATUS indicating the success of the unload request.

## **CALL**

The CALL subprograms cause control to be passed to the specified entry point of a program loaded via the LOAD function. The loaded program is assumed to be callable via the standard operating system calling conventions.

The ARG\_LINE parameter may be used to pass an argument list to the called program.

Under CMS, register R0 points to an untokenized argument control block, i.e. four fullwords containing addresses indicating the extended form of the command line as specified in the ARG\_LINE parameter. Similarly register R1 points to a tokenized argument list, i.e. a list of doublewords, one per argument (truncated to 8 characters), terminated with a doubleword consisting of all X'FF's. The top byte of register R1 has the value X'0B'. See CMS Command and Macro Reference (chapter 8) for a description of CMS command line parameter passing conventions.

Under MVS, register R1 points to a fullword containing the address of the argument string headed by a halfword field containing the length of the argument string.

The result of the CALL function is the return code of the called program.

## **EXECUTE**

The EXECUTE subprograms enable a dynamic call to be made to any program obeying the standard operating system calling conventions. A call to EXECUTE is equivalent to the sequence of calls: LOAD, CALL, UNLOAD.

## **EXECUTE\_COMMAND**

Under CMS the EXECUTE\_COMMAND subprograms with a non-null parameter execute the given CMS SUBSET command. The result of the EXECUTE\_COMMAND function is the return code of the command. If a null string is given as the parameter, the program exits to the CMS subset level. This allows CMS SUBSET commands to be executed directly. Issuing the command RETURN from the CMS subset level will return to the Ada program. The return code of the EXECUTE\_COMMAND function with a null COMMAND string is always zero.

Under MVS a call of the EXECUTE\_COMMAND subprograms has no effect and the function always returns the value zero.

## **STACK**

Under CMS the STACK procedure allows a command to be placed on the console stack: either last-in-first-out (LIFO) or first-in-first-out (FIFO).

Under MVS a call of the STACK procedure has no effect.

## **SENTRIES**

Under CMS, the SENTRIES function returns the number of lines in the program stack.

Under MVS, the SENTRIES function always returns the value 0.

## **ABORT\_PROGRAM**

The program may be aborted, returning the specified exit code, by a call of the ABORT\_PROGRAM procedure.

## **SYSTIME, USRTIME**

Under CMS the SYSTIME and USRTIME functions allow access to the amount of system and user time, respectively, used by the program since its execution.

Under MVS calls of SYSTIME always return the value 0.0. On MVS/XA USRTIME returns the amount of user time used by the program, while on MVS it returns the value 0.0.

## EXISTS

The EXISTS function returns a boolean to indicate whether the file specified by the file name string exists or not.

## LAST\_EXCEPTION\_NAME

The function LAST\_EXCEPTION\_NAME returns the name of the most recently raised exception in the current task. It may be used in handlers to identify the exception, e.g.:

```
...
when others =>
    TEXT_IO.PUT (SYSTEM_ENVIRONMENT.LAST_EXCEPTION_NAME);
    TEXT_IO.PUT_LINE (" raised");
```

#### 10.5.4 Package RECORD\_IO

The implementation-defined package RECORD\_IO enables an Ada program to perform simple, record oriented I/O of an anonymous data type in an efficient manner.

RECORD\_IO provides similar facilities to the predefined packages SEQUENTIAL\_IO and DIRECT\_IO in a non-generic form. The package is therefore "typeless": the data on which I/O is being performed being specified via its address and length. It is the programmer's responsibility to see that the data manipulated by the facilities of RECORD\_IO are handled in a consistent manner.

The specification of package RECORD\_IO is as follows:

```
with SYSTEM, IO_EXCEPTIONS;
package RECORD_IO is

  --          *****
  --          * TYPES *
  --          *****

  type COUNT is range 0..INTEGER'LAST;
  subtype POSITIVE_COUNT is COUNT range 1..COUNT'LAST;

  type FILE_TYPE is limited private;

  type FILE_MODE is (IN_FILE, INOUT_FILE, OUT_FILE);
  type FILE_ORGANISATION is (SEQUENTIAL, DIRECT);

  --          *****
  --          * FILE MANAGEMENT *
  --          *****

  procedure CREATE (FILE      : in out FILE_TYPE;
                   MODE       : in FILE_MODE := OUT_FILE;
                   NAME       : in STRING := "";
                   FORM       : in STRING := "";
                   ORGANISATION : in FILE_ORGANISATION := SEQUENTIAL;
                   TRANSLATE  : in BOOLEAN := FALSE);

  procedure OPEN (FILE      : in out FILE_TYPE;
                 MODE       : in FILE_MODE;
                 NAME       : in STRING;
                 FORM       : in STRING := "";
                 ORGANISATION : in FILE_ORGANISATION := SEQUENTIAL;
                 TRANSLATE  : in BOOLEAN := FALSE);

  procedure CLOSE (FILE : in out FILE_TYPE);
  procedure DELETE (FILE : in out FILE_TYPE);
  procedure RESET (FILE : in out FILE_TYPE;
                  MODE : in FILE_MODE);
  procedure RESET (FILE : in out FILE_TYPE);
```

```

function MODE (FILE : in FILE_TYPE) return FILE_MODE;
function NAME (FILE : in FILE_TYPE) return STRING;
function FORM (FILE : in FILE_TYPE) return STRING;

function IS_OPEN (FILE : in FILE_TYPE) return BOOLEAN;

--          *****
--          * INPUT / OUTPUT *
--          *****

procedure READ (FILE   : in FILE_TYPE;
               ITEM    : in SYSTEM.ADDRESS;
               LENGTH  : in out NATURAL);

-- Only for DIRECT organisation files
procedure READ (FILE   : in FILE_TYPE;
               ITEM    : in SYSTEM.ADDRESS;
               LENGTH  : in out NATURAL;
               FROM    : in POSITIVE_COUNT);

procedure WRITE (FILE   : in FILE_TYPE;
                ITEM    : in SYSTEM.ADDRESS;
                LENGTH  : in NATURAL);

-- Only for DIRECT organisation files
procedure WRITE (FILE   : in FILE_TYPE;
                ITEM    : in SYSTEM.ADDRESS;
                LENGTH  : in NATURAL;
                TO      : in POSITIVE_COUNT);
function END_OF_FILE (FILE : in FILE_TYPE) return BOOLEAN;

-- Only for DIRECT organisation files
procedure SET_INDEX (FILE : in FILE_TYPE;
                   TO    : in POSITIVE_COUNT);
function INDEX (FILE : in FILE_TYPE) return POSITIVE_COUNT;
function SIZE  (FILE : in FILE_TYPE) return COUNT;

--          *****
--          * EXCEPTIONS *
--          *****

STATUS_ERROR : exception renames IO_EXCEPTIONS.STATUS_ERROR;
MODE_ERROR   : exception renames IO_EXCEPTIONS.MODE_ERROR;
NAME_ERROR   : exception renames IO_EXCEPTIONS.NAME_ERROR;
USE_ERROR    : exception renames IO_EXCEPTIONS.USE_ERROR;
DEVICE_ERROR : exception renames IO_EXCEPTIONS.DEVICE_ERROR;
END_ERROR    : exception renames IO_EXCEPTIONS.END_ERROR;
DATA_ERROR   : exception renames IO_EXCEPTIONS.DATA_ERROR;

private
.
.
end RECORD_IO;

```

The specification of `RECORD_IO` is similar to that of the predefined generic packages `SEQUENTIAL_IO` and `DIRECT_IO`. The file management facilities provided are analogous: with `CREATE`, `OPEN`, `CLOSE`, `DELETE` and `RESET` procedures, in addition to `MODE`, `NAME`, `FORM` and `IS_OPEN` functions, as in the predefined packages. The syntax and semantics of file names and form strings are identical to those of the predefined packages, as described in section 8 of this appendix. The `CREATE` and `OPEN` procedures take two additional parameters, as below:

#### ■ ORGANISATION

The `ORGANISATION` parameter specifies the organization of the file being created or opened. Two types of organizations may be specified:

##### SEQUENTIAL

Sequential organized files correspond to files that could be created via an instantiation of the generic package `SEQUENTIAL_IO`. Records in a sequential organization file are variable length according to the length data written to them. A sequential organization file is implemented as a QSAM file under MVS.

A sequential organized file must be written and read sequentially. An attempt to pass a `FILE_TYPE` value representing a sequential organized file to the `READ` or `WRITE` procedures with an explicit specification of the file record to be read or written (`FROM` or `TO` parameters), or to use those subprograms which directly manipulate the file index (`SET_INDEX`, etc.) will raise `USE_ERROR`.

##### DIRECT

Direct organized files correspond to files that could be created via an instantiation of the generic package `DIRECT_IO`. Records in a direct organization file are fixed length according to the *record\_length* form parameter, which the user must specify when creating a direct organization file. Failure to specify the *record\_length* form parameter on creating a direct organization file will raise `USE_ERROR`, since there is no Ada type associated with the file to whose size the record length may default. A direct organization file is implemented as a BDAM file under MVS.

#### ■ TRANSLATE

The `TRANSLATE` parameter specifies whether ASCII to EBCDIC translation is to be performed on the data on output and whether EBCDIC to ASCII translation is to be correspondingly performed on input.

Use of the `TRANSLATE` parameter allows records of the external file to hold character data in an appropriate form for manipulation by other 370 tools expecting EBCDIC encoded character data.

The input-output facilities themselves are represented by overloaded `READ` and `WRITE` procedures.

These procedures are analogous to those of `SEQUENTIAL_IO` and `DIRECT_IO`. The data is specified via its address (`ITEM`) and length (`LENGTH`).

The external file is characterized by its `RECFM` and `LRECL` attributes. These may be explicitly controlled via the `FORM` parameter (see section 8.2) or else default as below:

<u>Organization</u>	<u>Attribute</u>	<u>Default</u>
Sequential	<code>RECFM</code>	V
	<code>LRECL</code>	4096
Direct	<code>RECFM</code>	F
	<code>LRECL</code>	No default

On output, `LENGTH` bytes of data are written to the appropriate record of the file from the address specified. If the `LENGTH` specified is greater than `LRECL` then `DATA_ERROR` is raised. If the `LENGTH` specified is less than `LRECL` and `RECFM` is F then the data is written at the start of the record. The remaining portion of the record will contain EBCDIC space characters (i.e. bytes whose value is 16#40#). If the `LENGTH` specified is less than `LRECL` and `RECFM` is V then a record of exactly `LENGTH` bytes is written, the `LRECL` specifying the maximum permissible record length.

On input, the appropriate record of the file is read at the address specified. If the length of the appropriate record of the file is less than `LENGTH` bytes, the entire record is read and the actual record length returned in `LENGTH`. If the length of the appropriate record of the file is greater than `LENGTH` bytes then `DATA_ERROR` is raised. Note that for a direct organization file the uninitialised portion of the record is considered to be part of the record length on input. It is the programmer's responsibility to read and write records via the facilities of `RECORD_IO` in a consistent manner.

`READ` and `WRITE` procedures with explicit specification of the file record to be read or written (`FROM` and `TO` parameters) are only applicable to files opened or created with direct organization. Application of these procedures to a sequential organization file will raise `USE_ERROR`.

The remaining input output facilities are analogous to the corresponding subprograms in `SEQUENTIAL_IO` or `DIRECT_IO`, with `END_OF_FILE`, `SET_INDEX`, `INDEX` and `SIZE` subprograms. `END_OF_FILE` is applicable to both sequential and direct organization files. The remainder however, are only supported for files opened or created with direct organization. Application of these procedures to a sequential organization file will raise `USE_ERROR`.

All other exceptional conditions raise the corresponding exceptions to those of the predefined I/O packages.

### 10.5.5 Package STRINGS

The implementation-defined package STRINGS is a utility package providing the user with many commonly required string manipulation facilities.

The specification of package STRINGS is as follows:

```
with UNCHECKED_DEALLOCATION;
package STRINGS is
```

```
--          *****
--          * TYPES *
--          *****
```

```
type ACCESS_STRING is access STRING;
procedure DEALLOCATE_STRING is new UNCHECKED_DEALLOCATION (STRING,
                                                         ACCESS_STRING);
```

```
--          *****
--          * UTILITIES *
--          *****
```

```
function UPPER (C : in CHARACTER) return CHARACTER;
function UPPER (S : in STRING) return STRING;
procedure UPPER (S : in out STRING);
```

```
function LOWER (C : in CHARACTER) return CHARACTER;
function LOWER (S : in STRING) return STRING;
procedure LOWER (S : in out STRING);
```

```
function CAPITAL (S : in STRING) return STRING;
procedure CAPITAL (S : in out STRING);
```

```
function REMOVE_LEADING_BLANKS (S : in STRING) return STRING;
function REMOVE_TRAILING_BLANKS (S : in STRING) return STRING;
function TRIM (S : in STRING) return STRING;
```

```
function INDEX (C      : in CHARACTER;
                INTO   : in STRING;
                START  : in POSITIVE := 1) return NATURAL;
```

```
function INDEX (S      : in STRING;
                INTO   : in STRING;
                START  : in POSITIVE := 1) return NATURAL;
```

```
function NOT_INDEX (C      : in CHARACTER;
                   INTO   : in STRING;
                   START  : in POSITIVE := 1) return NATURAL;
```

```
function NOT_INDEX (S      : in STRING;
                   INTO   : in STRING;
                   START  : in POSITIVE := 1) return NATURAL;
```



```

function IS_AN_ABBREV (ABBREV      : in STRING;
                      FULL_WORD   : in STRING;
                      IGNORE_CASE : in BOOLEAN := TRUE) return BOOLEAN;

function MATCH_PATTERN (S          : in STRING;
                      PATTERN     : in STRING;
                      IGNORE_CASE : in BOOLEAN := TRUE) return BOOLEAN;

function '&' (LEFT : in STRING; RIGHT : in STRING) return STRING;
function '&' (LEFT : in STRING; RIGHT : in CHARACTER) return STRING;
function '&' (LEFT : in CHARACTER; RIGHT : in STRING) return STRING;
function '&' (LEFT : in CHARACTER; RIGHT : in CHARACTER) return STRING;

end STRINGS;

```

## ACCESS\_STRING

The `ACCESS_STRING` type is a convenient declaration of the commonly used access to string type.

## DEALLOCATE\_STRING

The `DEALLOCATE_STRING` procedure is an instantiation of `UNCHECKED_DEALLOCATION` for the type `ACCESS_STRING`. Note that since the type `ACCESS_STRING` is declared at the library level, the scope of the corresponding collection is only exited at program completion. For this reason, `STRING` objects belonging to this collection are never automatically deallocated. It is the programmer's responsibility to manage the deallocation of objects within this collection.

## UPPER

The `UPPER` subprograms convert any lower case letters in their parameters to the corresponding upper case letters. Characters which are not lower case letters are unaffected. The procedure is more efficient than the corresponding function, as it does not make use of the program heap.

## LOWER

The `LOWER` subprograms convert any upper case letters in their parameters to the corresponding lower case letters. Characters which are not upper case letters are unaffected. The procedure is more efficient than the corresponding function, as it does not make use of the program heap.

## **CAPITAL**

The CAPITAL subprograms "capitalize" their parameters. That is they UPPER the first character and LOWER all subsequent characters of the string. The procedure is more efficient than the corresponding function, as it does not make use of the program heap.

## **REMOVE\_LEADING\_BLANKS**

The REMOVE\_LEADING\_BLANKS function returns its parameter string with all leading spaces removed.

## **REMOVE\_TRAILING\_BLANKS**

The REMOVE\_TRAILING\_BLANKS function returns its parameter string with all trailing spaces removed.

## **TRIM**

The TRIM function returns its parameter string with all leading and all trailing spaces removed.

## **INDEX**

The INDEX subprograms return the index into the specified string (INTO) of the first character of the first occurrence of a given substring (S) or character (C). The search for the substring or character commences at the index specified by START. If the substring or character is not found, the functions return the value 0. Case is considered significant.

## **NOT\_INDEX**

The NOT\_INDEX subprograms return the index into the specified string (INTO) of the first character which does not occur in the given string (S) or does not match the given character (C). The search for the non-matching character commences at the index specified by START. If all the characters of the string match, the functions return the value 0. Case is considered significant.

## **IS\_AN\_ABBREV**

The IS\_AN\_ABBREV function determines whether the string ABBREV is an abbreviation for the string FULL\_WORD. Leading and trailing spaces in ABBREV are first removed and the trimmed string is then considered to be an abbreviation for FULL\_WORD if it is a proper prefix of FULL\_WORD.

The parameter IGNORE\_CASE controls whether case is considered significant or not.

## **MATCH\_PATTERN**

The **MATCH\_PATTERN** function determines whether the string **S** matches the pattern specified in **PATTERN**. A pattern is simply a string in which the character **"\*\*"** is considered a wild-card which can match any number of any characters.

For example the string **"ABCDEFGH"** is considered to match the pattern **"A\*G"** and the pattern **"ABCD\*EFG\*\*"**

The parameter **IGNORE\_CASE** controls whether case is considered significant or not.

The package **STRINGS** also provides overloaded subprograms designated by **'&'**. These are identical to the corresponding subprograms declared in package **STANDARD**, except that the catenations are performed out of line. By performing catenations out of line the size of the inline generated code is minimized at the expense of execution speed.

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## APPENDIX C

## TEST PARAMETERS

Certain tests in the ACVC make use of implementation-dependent values, such as the maximum length of an input line and invalid file names. A test that makes use of such values is identified by the extension .TST in its file name. Actual values to be substituted are represented by names that begin with a dollar sign. A value must be substituted for each of these names before the test is run. The values used for this validation are given below:

<u>Name and Meaning</u>	<u>Value</u>
\$ACC_SIZE An integer literal whose value is the number of bits sufficient to hold any value of an access type.	32
\$BIG_ID1 Identifier the size of the maximum input line length with varying last character.	(1..254=>'A', 255=>1)
\$BIG_ID2 Identifier the size of the maximum input line length with varying last character.	(1..254=>'A', 255=>2)
\$BIG_ID3 Identifier the size of the maximum input line length with varying middle character.	(1..127=>'A', 128=>3, 129..255=>'A')
\$BIG_ID4 Identifier the size of the maximum input line length with varying middle character.	(1..127=>'A', 128=>4, 129..255=>'A')
\$BIG_INT_LIT An integer literal of value 298 with enough leading zeroes so that it is the size of the maximum line length	(1..252=>0, 253..255=>298)
\$BIG_REAL_LIT A universal real literal of value 690.0 with enough leading zeroes to be the size of the maximum line length.	(1..249=>0, 250..255=>69.0E1)
\$BIG_STRING1 A string literal which when catenated with BIG_STRING2 yields the image of BIG_ID1.	(1..127=>'A')



---

\$BIG_STRING2	(1..127=>'A', 128=>1)
A string literal which when catenated to the end of BIG_STRING1 yields the image of BIG_ID1.	
\$BLANKS	(1..235=>' ')
A sequence of blanks twenty characters less than the size of the maximum line length.	
\$COUNT_LAST	2147483647
A universal integer literal whose value is TEXT_IO.COUNT'LAST.	
\$DEFAULT_MEM_SIZE	2147483647
An integer literal whose value is SYSTEM.MEMORY_SIZE.	
\$DEFAULT_STOR_UNIT	8
An integer literal whose value is SYSTEM.STORAGE_UNIT.	
\$DEFAULT_SYS_NAME	IBM_370
The value of the constant SYSTEM.SYSTEM_NAME.	
\$DELTA_DOC	2#1.0#E-31
A real literal whose value is SYSTEM.FINE_DELTA.	
\$FIELD_LAST	255
A universal integer literal whose value is TEXT_IO.FIELD'LAST.	
\$FIXED_NAME	NO_SUCH_TYPE
The name of a predefined fixed-point type other than DURATION.	
\$FLOAT_NAME	NO_SUCH_TYPE
The name of a predefined floating-point type other than FLOAT, SHORT_FLOAT, or LONG_FLOAT.	
\$GREATER_THAN_DURATION	100000.0
A universal real literal that lies between DURATION'BASE'LAST and DURATION'LAST or any value in the range of DURATION.	
\$GREATER_THAN_DURATION_BASE_LAST	10000000.0
A universal real literal that is greater than DURATION'BASE'LAST.	

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\$HIGH_PRIORITY	10
An integer literal whose value is the upper bound of the range for the subtype SYSTEM.PRIORITY.	
\$ILLEGAL_EXTERNAL_FILE_NAME1	T??????? LISTING A1
An external file name which contains invalid characters.	
\$ILLEGAL_EXTERNAL_FILE_NAME2	TOOLONGNAME TOOLONGTYPE TOOLONGMODE
An external file name which is too long.	
\$INTEGER_FIRST	-2147483648
A universal integer literal whose value is INTEGER'FIRST.	
\$INTEGER_LAST	2147483647
A universal integer literal whose value is INTEGER'LAST.	
\$INTEGER_LAST_PLUS_1	2147483648
A universal integer literal whose value is INTEGER'LAST+1.	
\$LESS_THAN_DURATION	-100000.0
A universal real literal that lies between DURATION'BASE'FIRST and DURATION'FIRST or any value in the range of DURATION.	
\$LESS_THAN_DURATION_BASE_FIRST	-10000000.0
A universal real literal that is less than DURATION'BASE'FIRST.	
\$LOW_PRIORITY	1
An integer literal whose value is the lower bound of the range for the subtype SYSTEM.PRIORITY.	
\$MANTISSA_DOC	31
An integer literal whose value is SYSTEM.MAX_MANTISSA.	
\$MAX_DIGITS	18
Maximum digits supported for floating-point types.	
\$MAX_IN_LEN	255
Maximum input line length permitted by the implementation.	

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\$MAX_INT	2147483647
A universal integer literal whose value is SYSTEM.MAX_INT.	
\$MAX_INT_PLUS_1	2147483648
A universal integer literal whose value is SYSTEM.MAX_INT+1.	
\$MAX_LEN_INT_BASED_LITERAL	(1..2=>'2:', 3..252=>'0', 253..255=>'11:')
A universal integer based literal whose value is 2#11# with enough leading zeroes in the mantissa to be MAX_IN_LEN long.	
\$MAX_LEN_REAL_BASED_LITERAL	(1..3=>'16:', 4..251=>'0', 252..255=>'F.E:')
A universal real based literal whose value is 16:F.E: with enough leading zeroes in the mantissa to be MAX_IN_LEN long.	
\$MAX_STRING_LITERAL	(1=>'"', 2..254=>'A', 255=>'")
A string literal of size MAX_IN_LEN, including the quote characters.	
\$MIN_INT	-2147483648
A universal integer literal whose value is SYSTEM.MIN_INT.	
\$MIN_TASK_SIZE	32
An integer literal whose value is the number of bits required to hold a task object which has no entries, no declarations, and "NULL;" as the only statement in its body.	
\$NAME	SHORT_SHORT_INTEGER
A name of a predefined numeric type other than FLOAT, INTEGER, SHORT_FLOAT, SHORT_INTEGER, LONG_FLOAT, or LONG_INTEGER.	
\$NAME_LIST	IBM_370
A list of enumeration literals in the type SYSTEM.NAME, separated by commas.	
\$NEG_BASED_INT	16#FFFFFFFF#
A based integer literal whose highest order nonzero bit falls in the sign bit position of the representation for SYSTEM.MAX_INT.	

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\$NEW_MEM_SIZE	2147483647
An integer literal whose value is a permitted argument for pragma memory_size, other than \$DEFAULT_MEM_SIZE. If there is no other value, then use \$DEFAULT_MEM_SIZE.	
\$NEW_STOR_UNIT	8
An integer literal whose value is a permitted argument for pragma storage_unit, other than \$DEFAULT_STOR_UNIT. If there is no other permitted value, then use value of SYSTEM.STORAGE_UNIT.	
\$NEW_SYS_NAME	IBM_370
A value of the type SYSTEM.NAME, other than \$DEFAULT_SYS_NAME. If there is only one value of that type, then use that value.	
\$TASK_SIZE	32
An integer literal whose value is the number of bits required to hold a task object which has a single entry with one inout parameter.	
\$TICK	0.01
A real literal whose value is SYSTEM.TICK.	

## APPENDIX D

## WITHDRAWN TESTS

Some tests are withdrawn from the ACVC because they do not conform to the Ada Standard. The following 44 tests had been withdrawn at the time of validation testing for the reasons indicated. A reference of the form AI-ddddd is to an Ada Commentary.

- E28005C      This test expects that the string "-- TOP OF PAGE. --63" of line 204 will appear at the top of the listing page due to a pragma PAGE in line 203; but line 203 contains text that follows the pragma, and it is this that must appear at the top of the page.
- A39005G      This test unreasonably expects a component clause to pack an array component into a minimum size (line 30).
- B97102E      This test contains an unintended illegality: a select statement contains a null statement at the place of a selective wait alternative (line 31).
- C97116A      This test contains race conditions, and it assumes that guards are evaluated indivisibly. A conforming implementation may use interleaved execution in such a way that the evaluation of the guards at lines 50 & 54 and the execution of task CHANGING\_OF\_THE\_GUARD results in a call to REPORT.FAILED at one of lines 52 or 56.
- BC3009B      This test wrongly expects that circular instantiations will be detected in several compilation units even though none of the units is illegal with respect to the units it depends on; by AI-00256, the illegality need not be detected until execution is attempted (line 95).
- CD2A62D      This test wrongly requires that an array object's size be no greater than 10 although its subtype's size was specified to be 40 (line 137).
- CD2A63A..D, CD2A66A..D, CD2A73A..D, CD2A76A..D [16 tests]  
These tests wrongly attempt to check the size of objects of a derived type (for which a 'SIZE length clause is given) by passing them to a derived subprogram (which implicitly converts them to the parent type (Ada standard 3.4:14)). Additionally, they use the 'SIZE length clause and attribute, whose interpretation is considered problematic by the WG9 ARG.
- CD2A81G, CD2A83G, CD2A84N & M, & CD5011O [5 tests]  
These tests assume that dependent tasks will terminate while the main program executes a loop that simply tests for task termination; this is not the case, and the main program may loop indefinitely (lines 74, 85, 86 & 96, 86 & 96, and 58, resp.).
- CD2B15C & CD7205C

These tests expect that a 'STORAGE\_SIZE length clause provides precise control over the number of designated objects in a collection; the Ada standard 13.2:15 allows that such control must not be expected.

- CD2D11B This test gives a SMALL representation clause for a derived fixed-point type (at line 30) that defines a set of model numbers that are not necessarily represented in the parent type; by Commentary AI-00099, all model numbers of a derived fixed-point type must be representable values of the parent type.
- CD5007B This test wrongly expects an implicitly declared subprogram to be at the the address that is specified for an unrelated subprogram (line 303).
- ED7004B, ED7005C & D, ED7006C & D [5 tests]  
These tests check various aspects of the use of the three SYSTEM pragmas; the AVO withdraws these tests as being inappropriate for validation.
- CD7105A This test requires that successive calls to CALENDAR.CLOCK change by at least SYSTEM.TICK; however, by Commentary AI-00201, it is only the expected frequency of change that must be at least SYSTEM.TICK--particular instances of change may be less (line 29).
- CD7203B, & CD7204B  
These tests use the 'SIZE length clause and attribute, whose interpretation is considered problematic by the WG9 ARG.
- CD7205D This test checks an invalid test objective: it treats the specification of storage to be reserved for a task's activation as though it were like the specification of storage for a collection.
- CE2107I This test requires that objects of two similar scalar types be distinguished when read from a file--DATA\_ERROR is expected to be raised by an attempt to read one object as of the other type. However, it is not clear exactly how the Ada standard 14.2.4:4 is to be interpreted; thus, this test objective is not considered valid. (line 90)
- CE3111C This test requires certain behavior, when two files are associated with the same external file, that is not required by the Ada standard.
- CE3301A This test contains several calls to END\_OF\_LINE & END\_OF\_PAGE that have no parameter: these calls were intended to specify a file, not to refer to STANDARD\_INPUT (lines 103, 107, 118, 132, & 136).
- CE3411B This test requires that a text file's column number be set to COUNT'LAST in order to check that LAYOUT\_ERROR is raised by a subsequent PUT operation. But the former operation will generally raise an exception due to a lack of available disk space, and the test would thus encumber validation testing.